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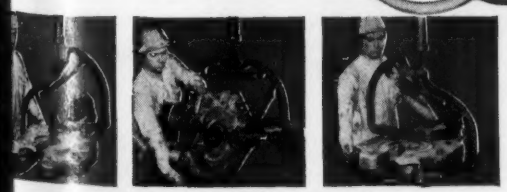

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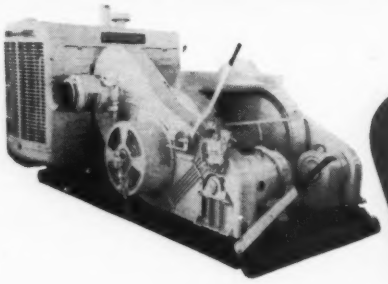

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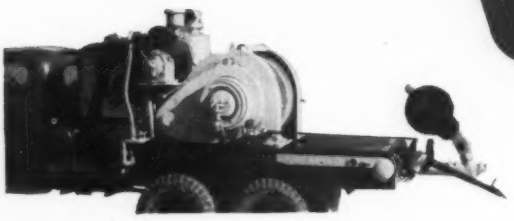

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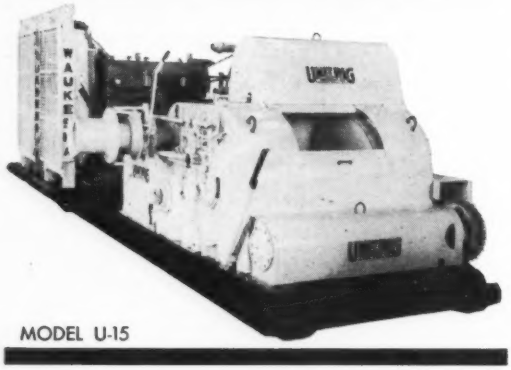

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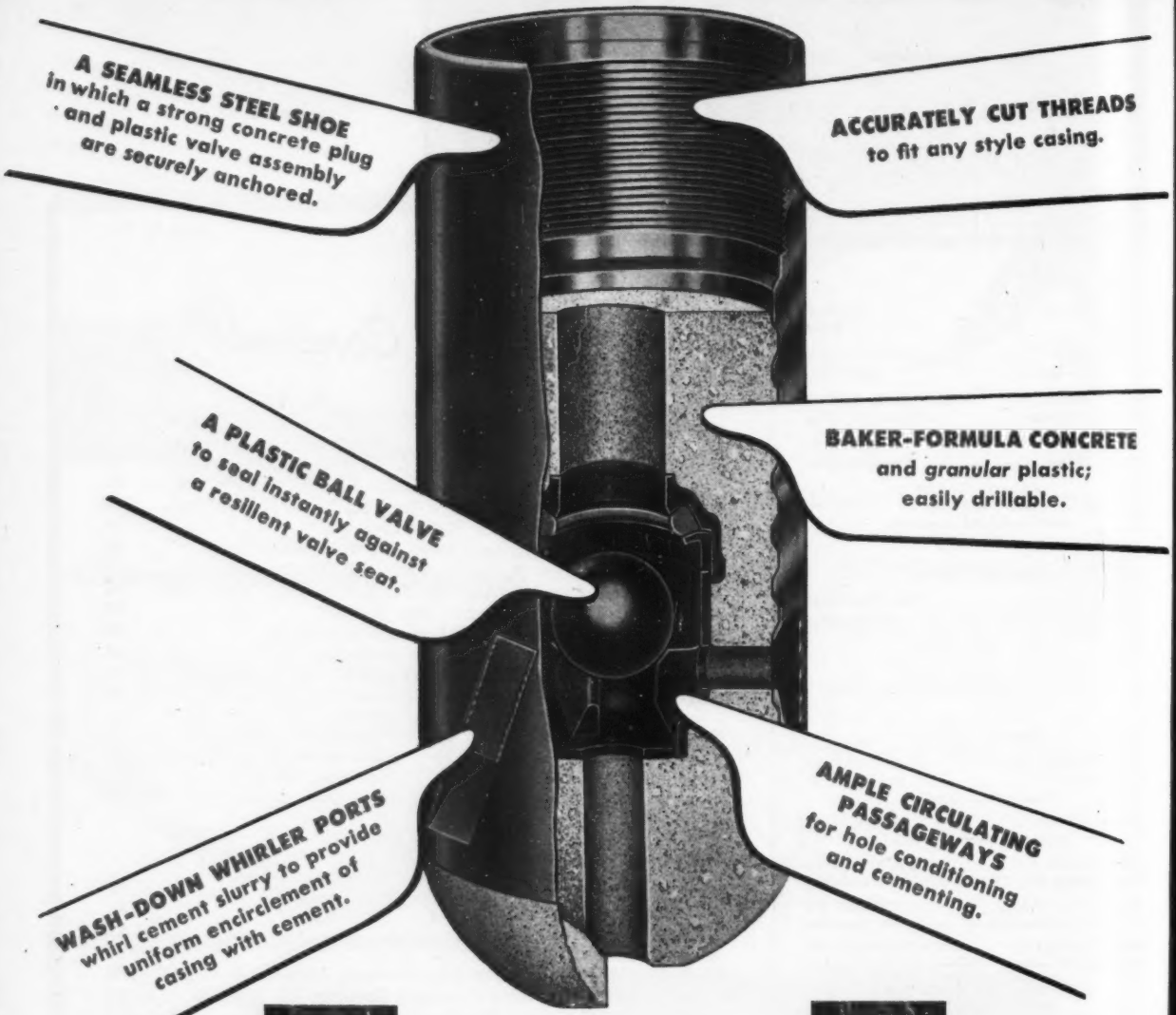
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THE OIL AND GAS JOURNAL

Coal Strikes

THERE is too little recognition at Washington and elsewhere that work stoppages at coal mines since the war's end have been of major significance in determining trends in petroleum operations and the nation's entire economy.

The latest strike of 29 days, which appeared to be officially ended Monday after the arrogant and unreasonable demands of a union dictator had again been largely acceded to by mine owners, has reduced coal supplies to the point where oil operations will be affected adversely at numerous points over the remainder of the year.

As has been explained in several reports appearing in the Journal in recent weeks, what the oil business can do over the next several months and later in increasing its domestic and foreign output in order to keep pace with rapidly increasing world demands is largely dependent on steel supplies, and the production of steel in turn is directly related to coal output.

Previous to the most recent coal strike there was every reason to believe that the oil business would be able to accomplish the 1948 objectives of its principal operating divisions, to the end that supply and demand would be in balance. But reports from manufacturers and suppliers of drilling, producing, transportation, and refining equipment now reveal that the latest shutting down of the mines extended over a long enough period to reduce steel production schedules. This has already been reflected in shipments to the oil industry and will delay deliveries throughout the year. Thus the oil business has been crippled again by developments over which it has no control.

For years the petroleum and natural-gas industries have been called upon to make up for the deficiencies of the coal business. Literally millions of new customers have come to oil and gas because the public lacks confidence in the labor leadership of the coal industry.

Indicative of what this has meant in oil operations, the 1947 increase in domestic demand for kerosine and distillate, formerly byproducts in refinery operations, totaled 69 million barrels, with an increase of 38 million barrels in residual fuel. The gains in these products, largely consumed as fuel, over the past 2 years have been nearly twice the increase in gasoline consumption which should continue to be the industry's principal product.

The oil industry, in addition to its present responsibilities, will be called upon to offset a large part of the estimated loss of 44,000,000 tons of coal production because of the strike. If there are shortages in fuel the coming winter the oil industry, not coal, will be blamed, as it has been in government investigations in recent months.

Oil operators have done an unprecedented job in expanding facilities. What is needed now in the interest of the entire nation is an end to the spineless and unrealistic approach to coal's labor and production problems.

Seismic Work Damage Suits Seen As Deterrent to Gulf Development

by Dahl M. Duff
District Editor, Houston

COMPANIES interested in Gulf of Mexico operations off the Texas coast, barred since last October from exploring unleased areas, are now facing the prospect of state litigation over payment for their earlier seismic work.

Reports in Austin say that suits against about 10 companies are now in process of preparation in the office of Price Daniel, Texas attorney general. They ask that the state be compensated for the geophysical work conducted in the Gulf of Mexico prior to last October 13 when Daniel in an opinion held there was no legal authority permitting exploration on unleased submerged lands.

The expected lawsuits are the latest move in a situation which threatens to retard seriously further exploratory work and oil development in the Continental Shelf area off Texas. It arose out of the failure of the last Texas Legislature to set up a satisfactory system whereby seismic work could be conducted on Gulf of Mexico lands not yet under lease.

Work Not Restricted

Prior to last October companies planning to take submerged leases off Texas conducted exploratory operations in whatever areas they chose without interference from the state. Most of the work was done in the months preceding the state's first submerged lease offering involving about 2,000,000 acres last November.

Daniel's opinion V-405, requested by Bascom Giles, general land office commissioner, was handed down less than a month prior to opening of bids at the November 4 lease sale. Exploratory work for the November 4 sale had been largely completed. In his opinion Daniel held geophysical exploration could be conducted only on lands under lease and that even seismic work must be cleared by a permit from the county judge authorizing the shooting.

One of Giles questions was whether the state was entitled to compensation for the "privilege of geophysical exploration of Gulf lands by those who do not have leases thereon." Daniel wrote: "We realize that it would be of great advantage to the School Fund in much higher bonus payments for leases if permits could be made (with adequate compensation) for the continuation of geophysical exploration of Gulf lands. We also realize that enforcement of our laws on this subject will hereafter restrict Gulf exploration work to lands now leased. . . . All these matters are within the province of the legislature." The state, Daniel continued, is justly due compensation in the form of damages for the reasonable value of the privilege exercised by those companies which have already explored the lands without leases thereon."

Operation Reports Asked

In February of this year Daniel addressed a letter to a number of companies known to have conducted exploration work in the Gulf. He asked that they submit to him complete information on the extent of their past geophysical operations. One major operator turned in this data, but as far as is known, the others did not.

In an interview in Austin, Daniel indicated his determination to see that the state receives payment for geophysical work in the Gulf. He said he considered some plan such as $50 a day per crew to be fair and that he would be willing to let the suits remain in court pending possible action by the next legislature. On the basis of the data submitted by one operator, Daniel said, this company would owe the state between $50,000 and $60,000 for past exploration.

Both state officials and oil industry sources seem agreed that some system permitting exploration on unleased lands is imperative if the submerged lands are to be fully developed. The industry's position generally is that the returns to the state in the form of higher bonuses will be much greater if exploration is encouraged by no fees, or at least a very nominal one.

The proposal before the last legislature died in committee. This measure (H.B. 50) would have levied a 50-cent an acre fee for exploration in the Gulf. Such an amount, in the opinion of industry leaders as well as some state officials, would have been prohibitive.

In the view of industry officials familiar with the situation, the system followed by Louisiana has encouraged oil exploration and consequent development off that state's Gulf Coast. Louisiana makes no charge for exploration work but requires a permit and also that a representative of the fishing commission accompany geophysical crews for the protection of marine life.

Prior to Daniel's opinion, there was widespread exploratory work conducted off the Texas Coast. On the basis of geophysical data obtained, companies paid approximately $7,000,000 in bonuses to Texas in the November sale. Some 378,000 acres of the 2,000,000 acres offered was taken. The total leased represents about one-sixty-fourth of Texas' total submerged offshore lands.

Whether the state could attract such active and high bidding in another similar sale is doubtful. Companies seem willing to take their chances on an ultimately secure state title to the "tidelands" but high offers for leases are necessarily predicated on geophysical data, which is not now obtainable on unleased lands.

In land operations and dealing with private owners, companies frequently enter into an arrangement paying for the right to conduct geophysical exploration but at the same time obtaining an option to lease a certain total of acreage within a specified time. This inducement to pay exploration fees does not exist with the state's offshore lands.

Leases Not Auctioned

Another feature of leasing offshore state land after conducting exploratory work is the fact that, unlike some other state leasing, offers are made on sealed bids and not at auction. While some large companies might take leases on very large areas at a nominal bonus, high bids for certain blocks would come only with fairly definite indications of a structure. In the November sale, bids ranged from as little as $3 to more than $150 on the same acreage.

There are a number of other ramifications involved in the problem of establishing an exploration system that will be fair to the state and at the same time promote offshore development. One official pointed out that it is not reasonable to assess a certain charge per shooting day. In many cases, crews are able to take only one or two shots before they are driven in by weather. This must be taken into account by using an average shooting day or a certain number of profiles as a basis.

Another question is the disclosure of company operations. Without the option privilege, companies should be allowed to obtain permits without revealing the exact area of exploration. Otherwise competing operators would be able to get at least general knowledge of favorable areas without exploratory work themselves.

In his opinion last October, Daniel said exploration was lawful on land which the company conducting the exploration had leased. In this case, he wrote, a Texas law aimed at the protection of fish and regulating the use of dynamite in state waters is applicable.

Corrosion Engineers Concentrate On Hydrogen-Sulfide Problems

by Paul Reed

ST. LOUIS. — Hydrogen-sulfide corrosion problems were widely discussed by those from the oil industry attending the National Association of Corrosion Engineers convention here April 5-8. Almost every paper in the oil-industry symposium dealt with "hydrogen blisters" and hydrogen embrittlement. Extensive observations made by M. H. Bartz and C. E. Rawlins, Phillips Petroleum Co., were amplified by E. Q. Camp, Humble Oil & Refining Co., and Nathan Schofer, Cities Service Refining Corp., in discussing the practical effects of hydrogen after penetrating steel. The characteristics which cause steel to transmit hydrogen, as defined in a pure research project, were presented later in the week by L. S. Darken and R. P. Smith, Research Laboratories, U. S. Steel Corp. Progress in this subject is significant to the oil industry because of the rising hydrogen-sulfur content of crudes as a result of increasing withdrawals from sour-crude areas.

An example of the broadening scope of corrosion sessions is the attendance of petroleum pipe-line engineers at the water-industry symposium and the interest expressed in the fast 24-hour method of J. W. Ryznar and Jerome Greene, National Aluminate Corp., for evaluating corrosion inhibitors with a revolving-drum procedure which gives results which are readily reproducible. The important effect of velocity was emphasized.

Since experimental cathodic protection of well casings in the Louden, Ill., field is a pioneering move toward the application of this technique, the comprehensive discussion of the subject by S. P. Ewing and J. F. Bayhi, Carter Oil Co., was regarded as significant for the future.

At the association's booth in the exhibit space attention was drawn throughout the convention to the samples of steels and alloys tested by the N.A.C.E. condensate well committee's investigation analyzed in the gas-industry symposium by V. V. Kendall, National Tube Co.

Electric Method Surprises

In the course of discussion during the salt-water-corrosion symposium, surprising results were presented regarding the rapid descaling of ships accomplished by a recent method applying d.c. electric current.

In describing an interesting pure research technique for the study of different types of iron oxides at different temperatures, E. A. Gulbransen, Westinghouse Research Laboratories, showed that chromium and cobalt have just one oxide regardless of temperature. This was regarded as valuable for those doing research on film formation. The study of alloys which will result in getting more protective films for withstanding corrosion is now only in its early stages.

Because of the black oxide film formed on aluminum brass, it is not as susceptible to erosion as admiralty metal when used for condenser tubes exposed to sea water. Such a protective film does not form on admiralty metal. This was pointed out in an informal discussion on the program led by F. R. Stauffacher, Southern California Edison Co.

Another example of a paper based on the results of advanced research techniques was that of E. R. Barnum, R. G. Larsen and A. Wachter, Shell Development Co., on rust preventive oils.

Complete Success Predicted

Evidence that it is possible completely to stop corrosion damage was presented by R. J. Kuhn in citing what had been accomplished in 20 years for protecting extensive utility facilities owned and operated by one concern in New Orleans.

Sand-blasting alone will not satisfactorily prepare metal surfaces for

(Continued on page 142)

Top officials and directors of the National Association of Corrosion Engineers at the group's fourth annual conference in St. Louis. Left to right, seated, are John M. Pearson, Sun Oil Co., Chester, Pa., 1948 recipient of the Frank Newman Speller Award and incoming director; E. P. Noppel, Ebasco Services, Inc., New York, director; A. B. Campbell, Houston, executive secretary; G. R. Olson, United Gas Pipe Line Co., Shreveport, outgoing president; F. L. LaQue, International Nickel Co., 1948-49 president; H. H. Anderson, Shell Pipe Line Corp., incoming vice president; and F. L. Goldsby, Chicago Bridge & Iron Co., New York, director and general chairman of the conference. Standing are Tom L. Holcombe, Dearborn Chemical Co., Shreveport, director; Vance N. Jenkins, Union Oil Co. of California, Wilmington, Cal., director; R. B. Mears, Carnegie-Illinois Steel Corp., Pittsburgh, director ex-officio and chairman of the technical-practices committee; L. A. Baldwin, Johns-Manville Corp., New York, director; H. M. Trueblood, director ex-officio and chairman of the policy and planning committee; and Mars G. Fontana, Ohio State University, Columbus, director

Coal Must Shoulder Bulk of New Home-Heating Load, Wilson Warns

A WARNING that the petroleum industry cannot produce fuel for all the oil burners manufacturers would like to sell was sounded in Chicago last week by Dr. George E. Wilson, chairman of the board of Standard Oil Co. (Ind.), before the Oil Heat Institute of America.

The bulk of any further increase in the home-heating load, Wilson said, will have to be taken up by natural gas and, especially, coal.

Coal production, he said, has shown no gain since 1918. "Of the amazing growth in our nation's energy consumption since then, 95 per cent has been supplied by increase in oil and natural-gas output. Water power has supplied 5 per cent."

No Apology Needed

The oil industry, he said, "need apologize for nothing." It increased its output of oil fuels 20 per cent in 1947 and expects further to increase the output 7 or 8 per cent this year.

"Criticism might justly be leveled against industries that have held back on expansion, or that have fallen far short of demand, but the oil industry does not fall in either category," he declared.

This potential 1948 increase in fuels output does not mean, he said, that the oil-burner industry can further increase its sales. Two per cent of that increase will be needed to fill new pipe lines and terminals and build up inventories, and the other 5 per cent "will be necessary to take care of the new oil burners which were installed in the latter half of last year and did not use their full annual requirements in 1947 but will do so in 1948."

Overselling of oil burners this year "may well have disastrous results for both our industries," Wilson warned. It would be better, he continued, if the burner industry would: (1) Make burners more efficient; (2) Concentrate on the replacement market; (3) Check burners during summer months; (4) Increase storage capacity at oil-burning homes; and (5) Give consumers only the facts about the oil supply.

Deceivers Criticized

He criticized "representatives of the burner industry" for denying any possibility of oil shortage last year "in spite of repeated warnings from leaders of our industry." Even worse, he said, "was the practice of some dealers in guaranteeing oil to purchasers of new burners when the only way they could supply it was to take it away from their regular customers."

"It was such practices as these," he continued, "that led even some of the ardent free-enterprisers in our industry to advocate severe restrictions on future oil-burner sales."

For the "long pull," Wilson suggested that stoker-fired coal be substituted for oil in home heating, and that the oil thus saved be converted into gasoline or diesel fuel for use in the field of transportation, where no simple substitute exists.

This, he said, would make more economic sense than continuing to use oil for home heating, when the oil must be made by the conversion of coal in a highly expensive synthetic process that sacrifices two-thirds of the coal's heating value.

Bohn Sees Adequate Supply

R. S. Bohn, institute president, told the group there will be enough additional fuel oil to adequately supply 10 per cent more power-driven oil burners than now in use without overtaxing oil supplies.

"On the basis of a factual survey recently completed on the capacities of the petroleum industry," Bohn said, "approximately 350,000 more power-driven oil burners than the 3,500,000 now in use can be installed this year. . . ." Replacements, he added would total about 150,000. "It is also estimated," he continued, "that about 650,000 additional space heaters can be installed," together with 350,000 replacement units.

Installation of new burners, he said, "will be made on a 'first come-first served' basis, until the capacity of fuel supplies has been reached. When that point is reached, the public will be so informed," he declared.

Bohn also outlined a program by which the oil-burner industry might encourage burner users to conserve oil.

New Gas Investigation Tied in With Defense

WASHINGTON. — A thorough investigation of the present gas supply and requirements and the ability of the nation's gas industry to meet any additional load resulting from any stepped-up defense program will be launched next month by the National Security Resources Board.

The board last week called in leaders in the electric utility field to discuss their situation and will set up the machinery for the gas study when Edward Falck, consultant to the chairman on power, gas and water, returns from Berlin late this month. At that time, the utility industries will be asked for their suggestions for the staffing of a power and utilities division which is to be set up under the board.

The gas investigation will cover the present situation and its effect on industry, proposed expansions of service programed by gas companies, the possible effect of the European recovery program on domestic utilities, and the extent to which the industry and its individual components can prepare themselves for mobilization and how much planning can be related to the over-all planning of the board.

Humble Reveals Plans For 1948 Expansion

HOUSTON.—If sufficient steel and other materials can be obtained, Humble Oil & Refining Co. will spend $140,000,000 in new facilities in 1948.

The Humble company made this announcement April 9 in a statement made in advance of the annual report. The announcement discussed the company's capital structure and said the directors at their meeting May 10 will recommend that capital stock be increased from $300,000,000 as presently shown on the books to $475,000,000.

The Humble policy of reinvesting a substantial part of its earnings, the statement continued, has increased net book investment in fixed assets to more than $480,000,000.

Of the $140,000,000, approximately $65,000,000 will be spent in the most expensive drilling program of the company's history. Over-all expenditures planned in all production-department activities total $110,000,000. Other Humble expenditures for the current year are: $16,000,000, refining; $7,500,000, pipe lines; and $6,500,000, other purposes.

Humble is the nation's largest crude producer. It produced 358,000 bbl. daily of crude oil and natural gasoline in 1947. Most of Humble's production is in Texas, although it has some producing properties in New Mexico, Louisiana, Mississippi, and Florida.

Earlier this year, Humble issued a statement outlining the magnitude of its drilling program. The $65,000,000 for drilling will be spent on an estimated 738 new wells, 163 more than were drilled last year. About one-third of the expenditures are planned for wildcats. Humble is planning three or four offshore wells in the Gulf of Mexico this year.

this week

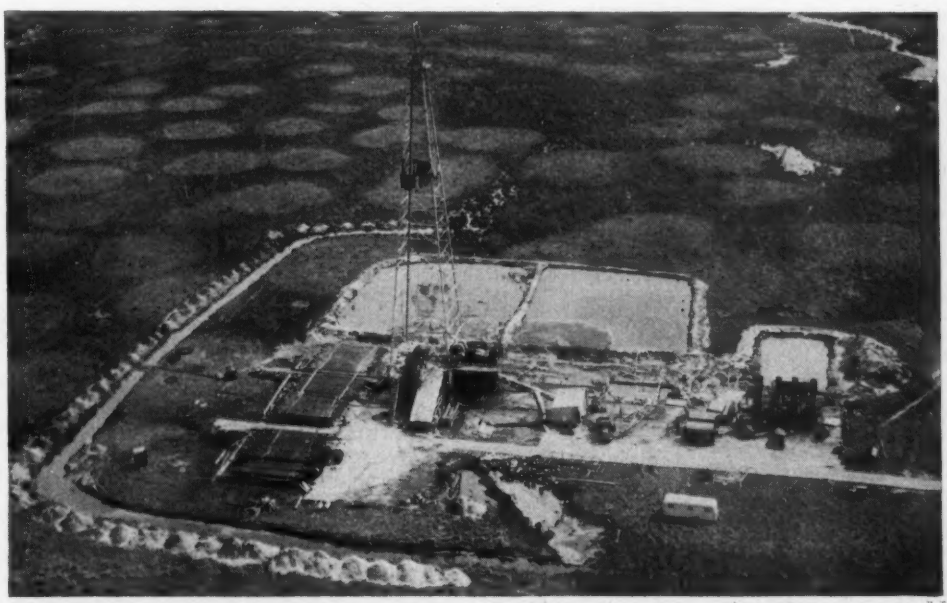
CONSERVATION—Extensive rate of exploration and development plus all possible conservation measures necessary to relieve nation's tight oil supply, Texas Railroad Commissioner Murray tells W.P.R.A. . . . ¶R. E. Wilson, board chairman of Standard Oil Co. (Ind.), tells Oil Heat Institute coal must shoulder bulk of new home-heating load. . . . Petroleum industry cannot produce fuel for all the oil burners manufacturers would like to sell, he says. . . . ¶Secondary recovery will provide theme for midyear meeting of directors of the Independent Petroleum Association of America, April 26-27, in Wichita . . .

SUPPLY—Adequate supply of fuel oil will be available to care for 350,000 more power-driven oil burners this year, R. S. Bohn, Oil Heat Institute president, tells members. . . . ¶Oil industry's $4 billion expansion program will bring productive capacity up to products demand within 2 years, E. O. Thompson, chairman of Texas Railroad Commission, tells Bradford Producers Association. . . . ¶Military petroleum requirements for the current fiscal year have been further reduced and procurement practically completed, H. W. Page, chairman of N.P.C. committee on military and government petroleum requirements, reports. . . .

INTERNATIONAL—Cities Service Co. agrees to provide capital for exploration and development by Pemex of more than 1,000,000 acres in northeastern Mexico. . . . A subsidiary company, Mexico-Cities Service Petroleum Corp., will provide the capital. . . . Exploration activities are to start immediately. . . . ¶Creole Petroleum Corp. reaches new all-time high in February with production of 626,210 bbl. daily. . . . ¶Capacity of Portuguese refinery to be expanded to 9,000-12,000 bbl. daily. . . . ¶Spain's wildcat in Lerida province is down to 7,000 ft. . . . Projected depth is 8,000 ft. . . . ¶Qatar No. 6 is rigging up. . . . No. 5 is below 4,000 ft. . . . No. 4 completed with 9,000 bbl. daily production. . . .

REFINING—Equipment for diesel-engine laboratory at Oklahoma A. & M. College, Stillwater, Okla., has arrived from Oberursel, Germany. . . . Office of Technical Service has allocated a fully equipped diesel-research laboratory there. . . . Oil industry assures financial assistance.

TRENDS—Gasoline stocks reach highest point in history at end of normal heating season, 113,530,000 bbl. . . . But this is only 44 1/2 days' supply on basis of Bureau of Mines estimated demand for second quarter. . . . Last year April 1 stocks were 105,330,000 bbl., or 44 days' supply. . . . Previous high gasoline stocks were spring of 1942, 107,000,000 bbl. or 60 days'. . . . April 1941 stocks were 99,000,000 or 50 days' supply, so current stocks are 12 per cent below prewar measured in days' supply. . . . ¶Crude production of 5,400,260 bbl. daily during week ended April 10 is 2,725 bbl. below previous week. . . . ¶Refinery runs recover from recent slump, reaching 5,475,000 bbl. daily during week ended April 3, slightly above 1948 average. . . . ¶Stocks of major products increase 2,000,000 bbl., all in gasoline, kerosine, and distillate, as residual falls off slightly. . . .



Current deepest producing well in Texas is Humble Oil & Refining Co. 1 South Mayes Gas Unit 1, about 2 miles south of South Mayes field in Chambers County on the Upper Gulf Coast. On initial production test February 22, the well flowed at the rate of 134.4 bbl. daily of condensate from 12,021-26 ft. It also produced 1,344,000 cu. ft. daily of gas through ⅛-in. choke with tubing pressure of 5,500 psi. Shut-in pressure is 6,300 psi. The well is shut in at present pending installation of surface production equipment for completion of further tests. When this photograph was taken, pumps already had been removed to the next location. The 1 South Mayes Unit was drilled by J. C. Means, Jr., Beaumont contractor, with total drilling time, including round trips, of 84.5 days and average progress below 10,000 ft. of 34 ft. daily. The location is in an area where some of the high subsurface pressures along the Gulf Coast have been encountered. In 1 South Mayes Unit, a protective string of 9⅝-in. casing was set at 10,054 ft., and 12-lb.-per-gal. mud carried to 11,900 ft. Mud weight to total depth was 15 lb. per gal.; 5½-in. casing was set at 12,029 ft.

Senate Approval of Rizley-Moore Bill Recommended by Committee

by Bertram F. Linz

WASHINGTON.—The Senate interstate commerce committee prepared a report last week recommendinf Senate approval of the Rizley-Moore bill to revise the Natural Gas Act, with amendments designed to meet objections raised to the House measure during its lengthy hearings last February.

As written for submission to the Senate, the bill makes it clear that Federal Power Commission jurisdiction does not extend to producers and gatherers of natural gas, nor to local distributors, and specifies that natural-gas production is not a utility function for inclusion in standards used by the commission for rate purposes.

"The purpose of the bill is to clarify, rather than alter in any fundamental way, the original intent of the present Natural Gas Act," the report declared.

"The bill leaves intact all authority and power of the commission to regulate effectively those activities and transactions of the natural-gas industry over which it is in the public interest to assert the federal regulatory power. Care has been taken, however, to leave no gap in the regulatory process over transportation, sale, and distribution. It is made clear that where the federal regulatory authority ends, regulation by the states begins."

States Control Gathering

The committee pointed out that the states effectively regulate the details of production and gathering as an intrastate operation, while field prices are determined by local competitive conditions. Likewise, the states regulate the rates and details of distribution of gas to the consumer and "no object in the public interest would be served by extending the Federal Power Commission's jurisdiction to distribution or to production and gathering even though closely and intimately associated with interstate operations."

The legislation, said the committee, "reaffirms the original intent of Congress to regulate the wholesale interstate transmission of gas from the point where it begins as wholesale transmission. . . "

The committee revamped the House provision relating to the prices to be allowed natural-gas companies for the purchase or production of gas in the fixing of rates. It retained that part of the original formula allowing the companies to figure as operating expense the actual price paid for gas purchased from nonaffiliates and nonsubsidiaries, but provided "actual price" for gas purchased through affiliates and subsidiaries and, in the case of gas produced by the company or a subsidiary or affiliate, the "reasonable commodity value of such gas in the field."

Smith, Wimberly Approve

The changes, it is explained, are substantially the language suggested by Chairman Nelson Lee Smith and Vice Chairman Harrington Wimberly of the FPC.

"This amendment," the committee continued, "is to give recognition to the fact that the production and gathering of natural gas is not a utility function. . . . The amendment recognizes that production of natural gas is an operation fraught with great speculative risk which will not and cannot be successfully carried on under public-utility regulatory standards. . . ."

In a review of the testimony taken at the hearings, the committee said it was "of the most convincing character that widespread uncertainty, doubt, and confusion exist as to the extent of the commission's jurisdiction over production and gathering of natural gas" because of the commission's application of the act to those activities, "contrary to the original intent of the Congress."

While the commission's practice has been sustained by the courts—albeit by sharply divided opinions in each case—the opinions and dissenting opinions have pointedly called attention to the fallacy of its methods, but indicated that until Congress provided another standard the commission was free to employ the one it had put into effect.

Could Relieve Oil Shortage

Further, it was declared, "the clarification of the Natural Gas Act and the removal of unnecessary restrictions which impede a proper development of the natural-gas industry have an important bearing upon national security. It cannot be overemphasized that by increasing the transportation and distribution of natural gas in the large consuming markets, there would be substantial relief of the oil shortage, and increased supplies of petroleum products would be available for military and other vital uses."

Summing up, the committee pointed out that natural-gas reserves today amount to the equivalent of almost 40 per cent more oil than the total crude reserves of the country, but very little gas in comparable heat energy is moving through interstate pipe lines into the large consuming areas in states, other than those where it is produced, and " a most serious shortage of natural gas in most consuming states has resulted from insufficient transportation facilities and efforts of the commission to regulate production and gathering of natural gas.

"The commission's policy, if continued, will encourage waste of natural gas where produced with oil. . . . It will seriously discourage sales of natural gas by oil companies or independent producers to interstate pipe lines. Utility regulation presupposes monopolistic conditions which do not exist in the production and gathering of oil and gas. Any such assumption by federal regulatory authority will force thousands of operators and owners of natural gas to dispose of it for carbon black or various other manufacturing purposes within the states where produced. Where natural gas is so used, it is not available for interstate transmission and ultimate distribution to the public."

REPRINTS AVAILABLE

A limited number of reprints of the 48-page three-color section: "Journal-Guide to Modern Refining Processes, 1948," from the Journal issue of April 1, 1948, are available. This section presents flow diagrams and brief discussions of operating principles for 44 leading refining processes. These reprints may be obtained for $1 per copy as long as the supply lasts. Address requests to Circulation Department, Box 1260, Tulsa 1, Okla.

Secondary Recovery to Be I.P.A.A. Meeting Subject

Secondary recovery will provide the theme of the midyear meeting of directors of the Independent Petroleum Association of America, to be held April 26-27 in Wichita, Kans.

Featured at the meeting, according to A. S. Ritchie, program chairman, will be a panel discussion led by R. C. Earlougher, Earlougher Engineering Co., Tulsa.

Preceding the panel, Richard V. Hughes, independent operator of Bradford, Pa., will address the group on "Research in Secondary Recovery."

Military, European Steel Needs To Affect Oil-Industry Quotas

WASHINGTON. — Steel men who have conferred with officials of the Department of Commerce office of industry cooperation have warned that while it may be possible to fill the oil industry's requirements for oil-country goods there will be no margin for exports, and the European Recovery Program, military expansion, and stockpiling of strategic materials will be important factors in the final decision in what and how much the industry will get.

Although the estimates prepared by the special National Petroleum Council committee headed by Russell B. Brown, general counsel of the Independent Petroleum Association of America, have not yet been ratified by the council and the Interior Department has not sent over its analysis of those estimates, the petroleum division of the OIC is making preliminary studies of its own on the basis of Brown's report.

The division is headed by Clifford A. Hahn of Boston, president of the Holtzer-Cabot Electrical Co., a consultant and engineer formerly with Stone & Webster. While admittedly not familiar with the oil industry, he has had considerable experience with public utilities, and his selection was in line with the War Production Board policy of getting outsiders, who might be considered impartial arbiters, to deal with industries in which there is a great diversity of activity and interest.

Associated with Hahn is Harold M. Bowman, who had 21 years' experience with Standard Oil Co. (N.J.), and he has asked NPC Chairman Walter C. Hallanan to recommend a couple of equally experienced men who can be taken into the division as consultants.

The OIC petroleum division will concern itself only with the steel requirements of the oil industry, the voluntary agreement for which will be supervised by the Interior Department. Hahn is working closely with Max Ball, director of the Oil and Gas Division, and petroleum experts in other branches of the Commerce Department.

Equality in 2 Years of Supply, Demand Seen

BRADFORD, Pa.—The oil industry's $4 billion expansion program will within 2 years, bring productive capacity up to the demand for products, Col. Ernest O. Thompson, chairman of the Texas Railroad Commission, told the Bradford Producers Association here last week.

Describing oil as "the greatest single agent in the world peace program," Thompson said gasoline rationing in the United States will not be necessary if European needs for oil are served from the Middle East and exports from the United States are curtailed while imports from South America are increased.

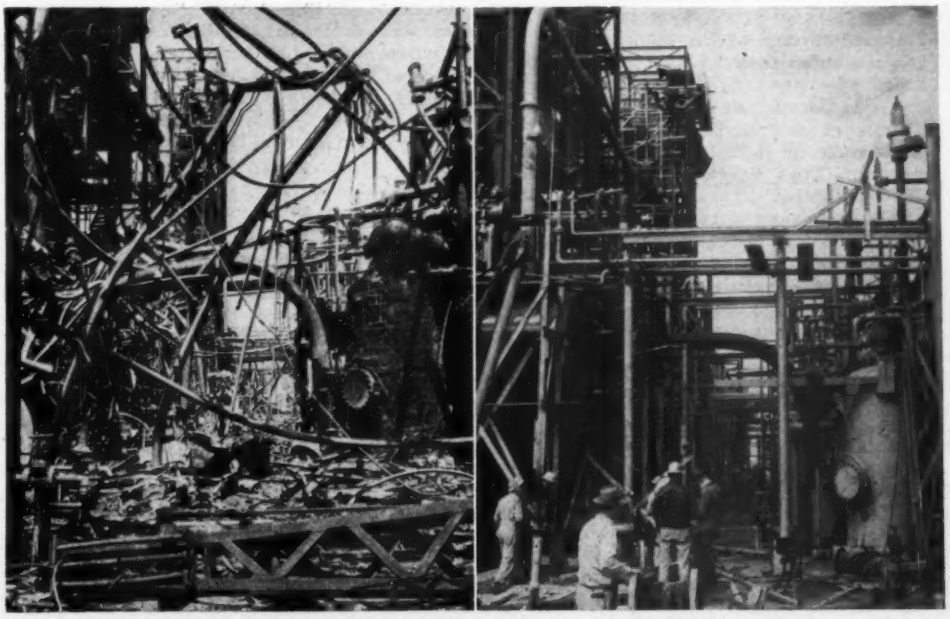
The solution to the current tight oil situation, he said, is "more steel to drill with, and more steel for additional pipe lines and tank cars, with the assurance of a continued adequate price" for crude oil.

Favors Natural Law

"If price is let alone for free play and steel is made available, we will have plenty of oil from new discoveries," Thompson said. "Then," he continued, "the supply will again bring the price down, as it always has when the law of supply and demand was permitted to operate without artificial controls."

Directors of the association were elected in a meeting April 8. They are:

D. T. Andrus, James Bird, A. E. Booth, R. J. Brennan, Jack Burns, G. H. Daggett, D. W. Daly, M. L. Dana, W. Fesenmyer, John Geibel, Hugh Grant, S. W. Gregg, Jr., G. H. Hanks, John Healey, J. P. Healy, E. G. James, J. P. Jones, Milton Landin, L. G. Lent, T. D. Mallory, Myron Matson, C. M. Oliver, C. N. Pfohl, Jr., R. S. Pringle, Jr., Robert Roy, Jr., A. J. Saxe, A. C. Simmons, Earl Smith, Lynn Smith, C. E. Streeter, D. B. Tanner, H. J. Walter, Roy Williams, A. L. Yerdon, and R. T. Zook, all of Bradford; Leonard Eberl and N. V. V. F. Munson, both of Olean, N. Y.; Harry Boylan, Cyclone; J. W. Bryner, Custer City; R. A. Digel, Smethport; and W. C. Schorman, Duke Center.



Illustrating the reconstruction being accomplished in Texas City, wrecked by explosions of the ammonium nitrate laden S.S. Grandcamp and S.S. High Flyer, April 16, 1947, are these photographs taken in the Monsanto Chemical Co. plant. Left is a portion of the plant as it appeared after the disaster. Right is a recent photo of the same area. Rebuilding of the Monsanto plant has proceeded steadily during the past year, and the complete plant is expected to be in production in June. The first unit, the ethylene plant, is to be in operation this month. Monsanto, currently negotiating an insurance claim for $22,317,937, largest single risk loss in insurance history, last week filed suit for $50,000,000 against the U. S. Government for all losses sustained in the explosion

International

WORLD-WIDE OIL DEVELOPMENTS

Cities Service Signs Contract to Finance Pemex Drilling Operations

NEW YORK.—W. Alton Jones, president of Cities Service Co., and Sen. Antonio J. Bermudez, general manager of Petroleos Mexicanos, this week signed a contract in Mexico City whereby Mexico-Cities Service Petroleum Corp., a Cities Service subsidiary, will provide capital for the exploration and development by Pemex of more than 1,000,000 acres of potential oil lands in northeastern Mexico.

While contract details were not announced, it is believed that several million dollars will be made available to Pemex to promote drilling operations on properties of four Cities Service subsidiaries in Mexico.

The areas covered by the Pemex-Cities Service contract are known as: San Jose de las Rusias; Sebino Gordo; Buena Vista de la Papayas; La Mision y Mogote; and Santiago de la Pena. The area covered by this contract aggregates more than 1,700 sq. miles.

Cities Service officials told The Oil and Gas Journal in New York that it is as yet undecided whether Pemex will handle all drilling operations or whether Cities Service will aid in these activities.

One company spokesman said he understood that the company will not receive crude oil under the contract other than the asphalt-base crude now being lifted from Pemex unless the projected program resulted in the discovery of additional reserves.

Reliable sources previously had indicated that regardless of the outcome of the drilling operations Cities Service would be accorded the privilege of purchasing additional amounts of crude oil.

It is understood that Cities Service previously had conducted exploratory work on the properties involved.

The official announcement of the signing of the contract, issued jointly by Jones and Bermudez, said:

"Under the contract Mexico-Cities Service Petroleum Corp. . . . will provide capital for the exploration and development by Petroleos Mexicanos of more than 1,000,000 acres of oil lands in northeastern Mexico.

"These lands were formerly controlled by subsidiaries of Cities Service Co. Before a development program could be completed, the Mexican Government took over the operation of oil properties in 1938, but an exception was made in the case of these Cities Service concessions. They were held by agreement with the Mexican Government in status quo and this action today is a culmination of negotiations over a period of time."

Jones said exploratory activities will be started immediately by Pemex.

The area covered by the contract, Jones said, "is one of the largest and most important in this hemisphere, and extensive geological and geophysical exploration work heretofore done indicates the presence of petroleum deposits, and there is every reason to believe the properties will yield large quantities of oil."

Jones said development of the areas, "easily accessible to water transportation and to world markets," can be carried on "with the minimum requirements of steel and other materials in short supply in the United States."

Qatar No. 6 Rigging Up; Fourth Well Completed

Qatar No. 6 is now rigging up, following the recent completion of Qatar 4 at 5,790 ft. Qatar 4 has a daily production of 9,000 bbl. This is the first postwar producer there.

The two Qatar producing wells which were completed during the war were so effectively plugged, when it was feared the Nazis might overrun the Persian Gulf Peninsula, that reconditioning would have been more expensive than drilling new wells.

Qatar 5 is now below 4,000 ft. Projected depth is around 5,700 ft.

Recent reports that American Independent Oil Co. was contemplating negotiations to become a partner of Petroleum Concessions (Qatar), Ltd., an affiliate of Iraq Petroleum Co., Ltd., are said to be unfounded.

Qatar is an independent sheikdom in the Persian Gulf. *(For a detailed on-the-spot article of wartime Qatar operations, see The Oil and Gas Journal, December 15, 1945, page 80).*

Creole Output Again Reaches New Record

REFLECTING the world demand for more crude-oil production, Creole Petroleum Corp.'s February output reached the new all-time high of 626,210 bbl. daily. This compares with 617,079 bbl. daily for January and 616,838 bbl. daily for December.

Of the February total, 468,441 bbl. came from the Lake Maracaibo area; 152,782 bbl. from eastern Venezuela; and 4,987 bbl. from Cumarebo.

Refinery runs totaled 70,720 bbl. daily during February, of which 61,086 bbl. were refined at Caripito and 9,634 bbl. at La Salina. The February total compares with 73,529 bbl. for January and 64,132 bbl. for last December.

Twenty-three development wells (the same as in January) were brought in as oil producers in February as well as two wildcats. Creole drilled four dry holes, two in the Jusepin area which averaged 3,713 ft.; one in Quiriquire which went down to 3,806 ft.; and one in Mulata, bottomed at 5,186 ft. Fields where producers were brought in, their average initial production and average depth follow:

Development: Bolivar Coastal (B.C. F.) 13, 629 bbl., 3,628 ft.; Quiriquire 8, 603 bbl., 4,253 ft.; Jusepin 1, 305 bbl., 4,605 ft.; and Temblador 1, 376 bbl., 4,010 ft.

Two wildcats were brought in as oil producers, one at Mulata with a depth of 5,904 ft. which had not been tested at the time of Creole's February report, and the other at San Joaquin which showed 309 bbl. at a depth of 5,715 ft.

Navy Asks More Funds to Explore "Another Maracaibo" in Alaska

WASHINGTON.—A $28,000,000 exploration program in Naval Oil Reserve No. 4, in Alaska, has been mapped by the Navy Department, and Congress has been asked for an appropriation of $15,000,000 to finance the work through the summer of 1951.

As a result of geological and geophysical work which indicates the presence of what Wallace Pratt, special assistant for petroleum matters to the chairman of the National Security Resources Board, said might turn out to be "another Maracaibo," special attention will be given the flat central plain which lies between the northern and southern parts of the reserve.

It is believed this plain overlays a great sedimentary basin favorable for the accumulation of oil. The lowermost section which is attractive for exploration is the Lisburne formation, which produces oil along the Rocky Mountain front in this country and Canada.

No Drilling This Summer

Because of uncertainty as to the future of the program which was initiated in 1944, no new drilling is expected to be undertaken this summer, it was stated by Comdr. William G. Greenman, director of naval petroleum reserves. A $9,600,000 appropriation for the exploration seasons 1946 through 1949 is half spent and the remaining funds are being conserved until it is determined whether the work will be continued or is to be closed out.

So far, in addition to the geophysical work, drilling has determined the presence of oil sands at several points, but with the exception of one well on the Umiat structure which produces 24 bbl. daily of rich oil, the sands have proven too impervious for any substantial production. Another well, at Cape Simpson on the Arctic Coast, has been drilled to 6,300 ft., where a considerable amount of gas was encountered, and is being pushed down into the underlying limestone.

Seepages Present

Numerous oil and gas seepages have been found scattered over the reserve, and if the necessary funds are provided it is planned to determine the relationship between the known and unknown areas and the oil seepages.

Immediate appropriation of the money is being sought, since buying must start now for the replacement of equipment and supplies for the 1949 field season, which must be shipped in by vessel to Point Barrow this summer so they may be moved over the ice next winter to the locations to be worked over during the following summer's open season.

Stepped-Up Kuwait Output Is Seen in Socony-Vacuum's Oil-Import Plans

STARTING in May, Socony-Vacuum Oil Co., Inc., will be importing approximately 17,000 bbl. daily of crude oil from Saudi Arabia, Iran, and Kuwait. This crude will be refined on the United States East Coast.

The Socony-Vacuum announcement of crude purchases from Kuwait is significant in that production there undoubtedly will be increased to far beyond the current 75,000 bbl. daily as soon as possible. Within the near future, the Royal Dutch-Shell hopes to be lifting around 200,000 bbl. daily from Kuwait, according to reliable sources, and this amount presumably would be only Gulf Exploration Co.'s 50 per cent share, in that the Shell contract is with Gulf and not with the other 50 per cent owner, Anglo-Iranian Oil Co., Ltd. This would mean that Kuwait's daily production will be pushed to at least 400,000 bbl.—and probably more.

Socony-Vacuum has been bringing in crude oil from Saudi Arabia to its Paulsboro (N. J.) refinery since last July and importing crude from Iran and Kuwait is a continuation of the company's efforts to meet the unprecedented demand for petroleum products in this country. The use of Iranian crude at Paulsboro will release some quantities of Texas crude for use in the company's refineries in the midwestern United States to make gasoline and heating fuels. Finished petroleum products from Iranian crude will be marketed in New York, New England and the Middle Atlantic states.

Socony-Vacuum has chartered 11 tankers of the T-2 type, or equivalent, to transport the oil. In addition, the company has arranged to have built seven new tankers, each of 26,500 tons deadweight. Three of these new tankers are scheduled to be ready for use in 1949.

The one-way trip for tankers from the Persian Gulf to Paulsboro takes about 30 days, including loading and discharging time.

International

Aramco Production Now Above 300,000 Bbl. Daily

Arabian American Oil Co. is currently producing more than 300,000 bbl. daily and refining about 125,000 bbl. daily in Saudi Arabia, according to Standard Oil Co. of California's 1947 annual report. California Standard is a 30 per cent partner of Aramco.

Daily crude-oil production on Bahrein Island is now 28,000 bbl., the report states, and 135,000 bbl. are being refined at Bahrein.

Concerning activities of Overseas Tankship Corp., of which California Standard is a 50 per cent owner, the report said that this company now operates 32 owned vessels, and 8 others have been purchased for 1948 delivery. "The number of tankers available for transportation of crude oil and products has a material bearing on the production level in the Middle East," it was explained.

No operations were undertaken in Sumatra last year by the Nederlandsche Pacific Petroleum Mij., 50 per cent owned by California, but activities will be resumed in that area as soon as political conditions permit, according to the report.

Harding Will Speak on Middle East Activities

Charles L. Harding, director of Socony-Vacuum Oil Co., Inc., in charge of the company's Middle East activities, is scheduled to speak April 20 before a convention of the Empire State Petroleum Association at the Hotel Roosevelt, New York.

Other speakers who will be on E.S.P.A.'s April 19 program include Jerry Cogan, coordinator of economics, Standard Oil Co. (N. J.); E. T. Knight, assistant director of economics, Atlantic Refining Co.; J. P. Patterson, vice president of Pan-American Petroleum & Transport Co.; and L. B. Fox, national fuel-oil manager of Socony-Vacuum.

Careful Research Led to Control Of Iranian Field's Odd Behavior

by H. S. Gibson

A NEARBY mountain having shown that a combination of fissures and porous limestone was responsible for oil production from the Masjid-i-Sulaiman field, Anglo-Iranian Oil Co., Ltd., built an "artificial fissure machine" and from it learned how to control the mechanism of production.

The original conception that the field was a "closed tank" was entirely reversed and it was demonstrated that dissolved gas drive rather than water drive or gas-cap drive was the motivating force in this, the fourth largest oil field in the world. The methods developed to get maximum recovery from the limestone of low permeability in southwestern Iran, revealed here in detail for the first time, may have an important bearing on the control of other limestone fields of the world.

This article is the second half of a condensation of the Redwood Award address of H. S. Gibson, general fields manager of Anglo-Iranian.

THE erratic behavior of some wells in Masjid-i-Sulaiman caused doubt that the oil was being produced entirely from fissures, as had been supposed earlier because of the extremely low permeability of the limestone.

A study of nearby Asmari Mountain, which proved to be a natural "scale model" of the field, showed that the oil-yielding fissures were much smaller and less frequent than had been assumed, and ranged from one-fiftieth to one-fifth of an inch in width. It was therefore theorized that while a well could produce only from fissures, the fissures were constantly replenished from the limestone mass itself, provided the pressure was proper and the rate of production was slow.

As a certain amount of doubt existed about this, it was decided to build an artificial fissure. Tests with this apparatus confirmed the evidence from the mountain as to the size of the fissures and the fact that fissure space available for storage of oil in the field was quite small. The device also helped to develop a method for calculating fissure widths from data on bottom-hole differential pressure.

A very interesting fact which emerged from the artificial fissure experiments was that about one-half of the total pressure drop into a well occurs within 18 in. of the hole, and that more than 95 per cent occurs within 50 ft. of the well. This means that unless a well has penetrated a fissure which behaves more or less as an extension of the hole, the bottom-hole differential is very unlikely to be able to cone up edge water unless the water is within 50 ft., and also that the pressure reduction at the foot of a well is applied to only a very small volume of limestone in the immediate vicinity.

By closing all producing wells simultaneously for 5 days and taking frequent observations, it was discovered that with a normal steady fall of 2½ in. per day in the gas-oil level, 20 per cent of the oil came from the fissures and 80 per cent from the porous limestone.

With this evidence, a reexamination of the reservoir rock was undertaken. The first step was to obtain some idea of the distribution of porosity in the Asmari limestone, which is approximately 1,000 ft. thick at Masjid-i-Sulaiman.

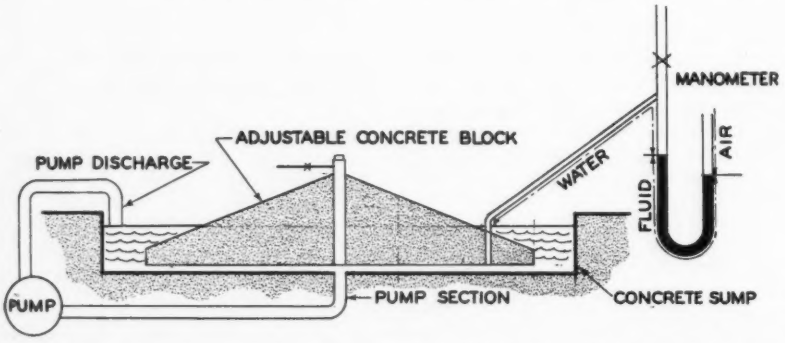
Limestone Like Charcoal

Fortunately it was noticed that a close relationship existed between the color and the porosity of various limestone samples. Although limestone is not preferentially wetted by oil it does adsorb the heavier material present in the crude. In fact, it was found by experiment that it was as effective as absorbent charcoal in this respect.

There is a definite relationship between the porosity and the permeability of the limestone. Occasionally samples of limestone having a porosity of as much as 20 per cent are found; the permeability of these is about 10 md., which is still far less than that of the average sand field, where the permeability generally runs from 50 to 500 md. Comparing these values with those of Asmari limestone there is little wonder that earlier opinion had been that the porous mass body limestone was a negligible factor in the production of oil.

Having obtained some idea of the porosity distribution in the field, it now became necessary to find out if oil really could be obtained from the porous limestone. A piece of limestone of about 10 per cent porosity was filled with crude oil and saturated with gas at 600 psi., the initial saturation pressure in the crest of the M-I-S reservoir. The pressure was then reduced, at the rate of 100 psi. per hour, down to atmospheric pressure. Oil was expelled from this limestone and was measured.

A total recovery of only 25 per cent was obtained, and of this four-fifths came out of the limestone in the first 200-psi. pressure drop. The experiment was repeated with a second sample of limestone and only 20 per cent recovery was obtained although the porosity of the sample



The "artificial fissure machine" which disproved the original theory that fissures are the main source of crude. It consisted of a circular concrete basin 14 ft. in diameter and 18 in. deep, with a 6-in. pipe running down from the middle. A circular block of concrete was cast in contact with the floor and arranged to be lifted with screwjacks to form a parallel-sided gap or fissure, varying from 1/50 to 1/5 in. Fluid from the basin was pumped down the hole through the fissure and the pressure drop was measured by a series of manometers set in the concrete block along a radius

was slightly higher than that of the first one. It may therefore be assumed that the oil was accompanied by its gas which had come out of solution.

The remarkable thing about these results is that they are practically identical with the results obtained with oil sands of much higher permeability.

The mechanism of expulsion is that known as "dissolved gas drive," which in sand fields gives a maximum recovery of oil in place of only 15 to 25 per cent, the porosity of the sand having very little effect on this amount. From this experiment with limestone it appeared that the very much lower permeability had negligible effect also, though one would have expected that with lower permeability and a consequent higher surface-volume ratio in the pores, a larger volume of oil would have been retained on the walls of the pores as an unrecoverable film.

Production Mechanism Seen

A fairly clear picture of conditions in the M-I-S reservoir having now been built up, it was possible to visualize the mechanism by which oil was obtained from it.

When production first began, the crude was initially drawn from the fissures, which in turn drained the fissures in the crestal region, so forming a gas dome in which the pressure was lower than the crude-oil saturation pressure in the porous limestone there. As the result of this lower pressure in the gas-filled fissures, oil would begin slowly to ooze from the rock above gas-oil level.

At the same time the loss of pressure in the oil zone occasioned by the replacement of oil by gas in the crest caused a zone or belt of reduced pressure to come into existence immediately below gas-oil level, the depth of this zone being equal in feet of oil to the difference between the saturation pressure at that point and the existing dome pressure. At the lower limit of the zone the saturation pressure and the oil pressure were equal.

This lower limit has been given the name of "saturation level." The result of this was that within this zone the oil pressure in the fissures was less than the saturation pressure in the adjacent porous limestone, so conditions existed for the oil to be expelled from the porous limestone into the fissures.

Dome Pressure Explained

As the oil came out of the limestone it was accompanied by bubbles of gas which had been in solution with it, but as soon as they entered the fissure these bubbles migrated upward to the gas dome. This explains why the fall of dome pressure is so very small.

With the slow fall of dome pressure the belt of reduced pressure gradually became deeper (or thicker) and traveled slowly downwards with the gas-oil level. Throughout this zone oil and gas are being expelled from the porous limestone, and it is now some 450 to 600 ft. deep. At a rough estimate 15 per cent of the gas originally in solution in the oil remains in the reservoir and helps to maintain the dome pressure.

It had become apparent that far from being of negligible value in the production of crude, porous limestone was responsible for the greater part of the production obtained. This was proved by observations of pressure changes in nearby Haft Kel field when production was suddenly increased. More than a year was required for the reservoir to settle down to the new rate, which is not at all like drawing oil from a tank. It was clear that the sudden increase in off-take was initially met from oil in the fissures, and this caused a sudden increase in the rate of fall of the pressure. This then acted as an increased differential pressure on the limestone, which responded very slowly.

Water Was Compressed

A fact which should not be overlooked is that a reservoir such as M-I-S contains an enormous volume of fluid in porous limestone below oil-water level, and that the reduction of pressure due to production, amounting to an average of about 15 psi. per annum, is effective on this fluid. Although the compressibility of fluids is very small, when large volumes are concerned the effect can be quite appreciable. It is now accepted that the rise in edge water in several oil fields is due entirely to the decompression of water.

In 1937 a well which had been producing 1,000 tons (7,700 bbl.) per day suddenly began to produce water shortly after the off-take from the field had been increased from 11,000 tons to 16,000 tons per day.

The reason would appear to be that at the normal slow rate of rise the water has time to enter porous limestone and displace crude, and that when the rise is rapid there is no time for this to take place, and the water being confined to the small-volume fissure system has a greatly magnified effect. The well was shut

Topping plant of Anglo-Iranian Oil Co., Ltd., at Bibian in Masjid-i-Sulaiman field, showing the rugged terrain. This section of the field has more fissures than any other and hence the rate of production can be increased more rapidly here without disturbing the delicate balance which makes M-I-S one of the world's greatest producers

International
WORLD-WIDE OIL DEVELOPMENTS

in for 4 months and then reopened to production, being then absolutely free from water, and the oil-water level had returned to its normal position.

This incident showed very clearly that a sudden increase in the rate of fall of pressure at oil-water level must be avoided, and the rate of increase of off-take from M-I-S was therefore limited to 20 per cent in 1 month.

The displacement of crude from porous limestone by water was examined experimentally and it was found that a differential head was required to initiate the flow of water into oil-filled limestone, the head depending upon the porosity of the sample under test. The quantity of oil displaced, however, seems to be more or less a constant proportion of the total oil in the limestone, amounting to something between 10 and 15 per cent.

It would therefore seem to be less efficient than the recovery by dissolved-gas drive. Once a block of limestone has been completely submerged by water there can be no increase of differential, and therefore no recovery.

Fissures Very Important

Although it has now become quite clear that porous limestone is responsible for the greater part of the production and that the quantity obtained from fissure space amounts probably to something of the order of 10 per cent only, the importance of the fissures must not be minimized, because without them production would be impossible. The Bibian sector of M-I-S is far more fissured than any other part of the field and its productivity has been greater. It has been found that the rate of production can be increased faster at Bibian without damage than in other parts of the field for this same reason.

Assuming that oil left behind above gas-oil level is deferred production and will eventually be obtained, the optimum and maximum rates of production for a field depend upon the rate of rise of edge water. If the rate of rise of edge water is fairly slow and uniform and there are no sudden and erratic movements, then the rate will not be far removed from the optimum. If, on the contrary, edge-water movements are erratic but are not subject to a general rapid rate of rise, it can be assumed that it would not be safe to increase the off-take beyond that amount.

Provided the rate of production is such that the oil-water level rises at a reasonable rate the only other limitation is the permeability of the limestone. Experience at M-I-S is that the off-take from the field should not exceed 5 per cent per annum of the remaining recoverable crude in the reservoir. This seems to have worked very well, but the great difficulty in applying it is the estimation of the remaining reserves. The slower the rate of production the greater seem the reserves, and vice versa.

Gas Pressure Kept Low

The value of gas conservation at M-I-S was fully appreciated and the dome pressure was maintained with gas which had been expelled together with oil, from the porous limestone. For this oil and gas to come out of the porous limestone it was essential that the pressure in the fissure system should be lower than the saturation pressure of the oil in the rock, and yet the gas which collected in the dome and maintained the pressure there was also maintaining a similar pressure throughout the fissure system.

The maintenance of dome pressure is therefore preventing oil and gas from coming out of the porous limestone into the fissures. Instead of being allowed to collect in the dome and thus hinder the production of oil, the gas should be produced with the oil to which it belongs. The gas-oil ratio of the crude coming from porous limestone is approximately 45 to 1, and the average gas-oil ratio of the crude arriving at the surface at the present time is about 35 to 1. The other 10 volumes are collecting in the gas dome.

It is not physically possible to produce all of the gas which belongs to the crude with the crude, but that is not necessary, for all that has to be done is to produce sufficient gas from the dome to bring the over-all producing gas-oil ratio up to 45 to 1. It is estimated that within the producing life of M-I-S about 15 per cent of the gas originally in solution in the crude produced from porous limestone has been collected in the gas dome.

Three Drives Recognized

Within the last 30 years considerable progress has been made in the improvement of the recovery of oil from sand reservoirs. Three different mechanisms are now generally recognized: water drive; gap-cap drive; dissolved-gas drive. They are here given in the order of their efficiency.

Both water drive and gas-cap drive require a sand of high uniform permeability to reach their greatest efficiency, and even then the rate of production must be restricted to something like 3 or 4 per cent of the estimated ultimate recovery, otherwise channeling and bypassing take place with consequent nonrecovery of oil.

It is clear that neither of these mechanisms would be very efficient in the limestone reservoirs of southwestern Iran with their enormous range of permeability, the range being from the infinite permeability of the fissures to that of the lowest-porosity limestone. Although experiment has shown that some 10 to 15 per cent of the oil in place can be recovered by displacement with water, the fortuitous nature of the fissuring would almost certainly prevent even this small recovery being effective over all the limestone submerged by rising edge water.

It is also clear from the effect of gas accumulation in the gas dome that the injection of gas to apply gas-cap drive to these limestone fields would not only be of no assistance, but would definitely reduce the amount of oil obtained, because it would put a back pressure on the limestone surfaces of the fissure system.

It will be recognized that the production mechanism of Masjid-i-Sulaiman is mainly dissolved-gas drive, with gravitational drainage from the fissures at gas-oil level and water drive in the fissures and porous limestone at oil-water level as subsidiaries.

The efficiency of dissolved-gas drive never exceeds about 25 per cent recovery of the total oil in place, the more normal being 15 to 20 per cent. To achieve even this amount it is necessary to reduce the pressure in the fissures considerably.

It must be recognized that no two oil fields are ever exactly alike. In these limestone fields the amount and variation of fissuring, the arrangement and occurrence of various types of limestone, the edge-water conditions, and the saturation pressures of the crude, all affect the production mechanism and recovery of oil.

An adequate number of observation wells by which the gas, oil, and water pressures and levels can be recorded is essential for the efficient control of the field, and to enable unforeseen occurrences to be quickly diagnosed and dealt with.

Capacity of Portuguese Refinery Being Tripled

LONDON.—The Portuguese refinery at Cabo Ruivo is being expanded from 3,000-4,000 bbl. capacity per day to approximately three times that capacity. The company operating this plant, SACOR, is owned one-third by the Portuguese Government and two-thirds by private interests.

The expansion plans include a primary distillation unit, a reforming unit, and a lubricating-oil plant. Engineering consultant on this program is Harold Moore, well-known British technologist and consulting engineer, who built the original refinery in 1938-39.

Conservation, Record Production Rate Essential, W.P.R.A. Told

GALVESTON.—The public cannot look to refining industry to relieve the current tight oil supply by simply building more plants, since the bottleneck will be the ability of the nation to produce and supply more crude oil, W. J. Murray, Jr., Texas Railroad commissioner, told the Western Petroleum Refiners Association here last week.

The solution, Murray said, lies in exploration and development at a rate greater than anything in the industry's history. Secondly, he declared, all possible conservation measures should be employed to obtain maximum recovery.

Murray was one of the four principal general session speakers at the association's thirty-sixth annual convention. The meeting also included several technical sessions. *(The Oil and Gas Journal, April 8, page 40)* and various entertainment features. The association reelected its major officers, including H. T. Ashton, Socony-Vacuum Oil Co., Inc., St. Louis, W.P.R.A. president.

In his remarks on current crude-oil supply—a matter of top importance to practically all refiners—Murray mentioned the possibility that Texas' total production will be reduced as a result of the hearings now being held by the commission to revise the maximum efficient producing rates for the state's larger fields.

Although the hearings continue the remainder of this month, the commissioner said the results thus far show a downward trend in MER's. "When we find that fields can produce more without damage, we will raise them," he told the refiners. "At the same time our duty is clear, that when engineering data shows fields wastefully producing we must cut them.

"Some people in the North and East have a misconception that we are holding back on production in this state for some such reason as to force higher oil prices. . . . The fact is that we are now producing all the oil in Texas that we can."

Murray told the refiners they were due all possible recognition for their achievements, both during the war and since, in meeting demand. "You have made a more rapid conversion than any other industry," he said. "You have kept obsolete equipment running and built new facilities. The public is inclined to become overcritical when they don't get all the products when they want them and where they want them, but before they become too critical, they should know the amazing job you've done."

More L.P.G. in Motor Fuel

As chairman of the Texas Emergency Fuel Commission which aided in relieving the state's spot L.P.G. shortages last winter, Murray said the refiners also should be given credit for diverting large quantities of butane and propane to domestic consumption during cold weather. He pointed out the sharply seasonal trend of L.P.G., and while admitting the difficulties involved, said refiners should do whatever possible at the present time of oversupply to use the lighter fractions in motor fuel.

Walter S. Hallanan, president of Plymouth Oil Co. and chairman of the National Petroleum Council, who followed Murray on the program, warned that "we should not permit the threat of war to bring about in peacetime a restoration of those controls that will lead to permanent control of the oil industry."

Hallanan said there is an insidious attack being made against the industry, partly under the cover of guaranteeing an adequate supply for the military forces. "When we talk of restoration of government controls, as some in Washington are doing, we should not forget that all the government regulations have never produced one barrel of oil or built one mile of pipe line," he asserted.

The NPC chairman described last year's tidelands decision as "a potential bomb under all property rights in America." There is, he continued,

(Continued on page 142)

Officers and directors of the Western Petroleum Refiners Association are shown here at the association's thirty-sixth annual meeting in Galveston. Seated: R. R. Irwin, Socony-Vacuum Oil Co., Inc.; J. C. Day, W.P.R.A. secretary-treasurer; R. W. McDowell, Mid-Continent Petroleum Corp., association vice president; R. L. Tollett, Cosden Petroleum Corp., association vice president; H. T. Ashton, Socony-Vacuum Oil Co., Inc., W.P.R.A. president; and H. W. Camp, Cities Service Oil Co. Standing: Reid Brazell, Leonard Refineries, Inc.; A. M. Hughes, Phillips Petroleum Co.; R. E. Luton, Ohio Oil Co.; J. W. Vaiden, Skelly Oil Co.; W. W. Vandeveer, Allied Oil Co.; Fayette B. Dow, W.P.R.A. general counsel; Rex H. Winget, Midland Cooperative Wholesale (Cushing Division); W. F. Sims, Panhandle Producing & Refining Co.; and F. H. Dunn, Wilcox Oil Co. Not shown are T. A. Helling, El Dorado Refining Co., and T. M. Martin, Lion Oil Co., vice presidents, and the following directors: Paul G. Blazer, Ashland Oil & Refining Co.; Sheldon Clark, Sinclair Refining Co.; O. L. Cordell, Bareco Oil Co.; F. L. Martin, Sunray Oil Corp.; W. E. Moody, Deep Rock Oil Corp.; I. A. O'Shaughnessy, Globe Oil & Refining Co.; Roland V. Rodman, Anderson-Prichard Oil Corp.; J. W. Warner, Tide Water Associated Oil Co.; and C. B. Watson, Pure Oil Co.

WASHINGTON WATCHING

BY BERTRAM F. LINZ

Arms for Europe

WASHINGTON.—A new lend-lease program in a figure of around $2,000,000,000 a year is under consideration in administration circles, designed to permit the shipment of arms and munitions of war to western Europe.

Such exports are not provided for in the European recovery program, and there is a definite feeling in both administration and congressional circles that western European defenses should be built up. In effect, the United States would tell the Marshall plan countries it was helping them toward economic recovery and was ready to help them defend those gains.

It probably will be some time before the new lend-lease program is submitted to Congress, although some leading members of that body have been consulted with a view to securing their support, and many phases must still be worked out in discussions with State Department and other officials.

Because the whole matter is still in the realm of preliminary study, there is little idea just how far it might go, but there is some speculation that oil might figure prominently in new lend-lease exports, just as it did under the lend-lease program in effect during the war.

It is pointed out there would be little justification in supplying tanks, mobile guns, airplanes, or other military material unless at the same time fuel was provided to make them effective. And the petroleum estimates of ERP are designed to cover essential industrial and civilian needs only.

The plan would have some advantage from the standpoint of domestic security, as well, since it would help to keep operating munitions plants in this country which the military are anxious shall be maintained in at least a state of readiness over the next few years.

The Mysterious Armenian

AT first glance there isn't much in common between the steel requirements of the oil industry and C. S. Gulbenkian, but Assistant Secretary of Commerce David K. Bruce managed to bring them together.

To a half-dozen members of the House interstate commerce committee who appeared interested in the steel situation, Bruce tossed a few tidbits of information about the "fabulous Armenian" who lives in a somewhat mysterious world from which he emerges occasionally with consequent substantial enrichment to himself.

Gulbenkian, Bruce explained, engineered the original negotiations whereby the former Turkish Petroleum Co. acquired a 75-year concession in Iraq, held before World War I by British and German interests, and he is also believed to have had much to do with the so-called "Red Line" agreement. For getting the concession, now held by Iraq Petroleum Co., Ltd., he received 5 per cent of the stock, and the other partners, which include the Near East Development Co. of Standard Oil Co. (N.J.) and Socony-Vacuum Oil Co., Inc., have been trying to buy him out for the past 2 years but find him a tough man to deal with.

Gulbenkian, who at various times has been a citizen of several different European countries, including Britain, is said to possess what is believed to be the largest private art collection in the world. Now stored in Paris, it was put under the protection of a South American embassy during the war.

Currently, he is residing in Lisbon where, said Bruce, he is "poised for flight to any place in the world."

It's a Man's Job

BROAD powers and equally broad problems will be laid on the shoulders of the man selected by President Truman to handle the European Recovery Program as Administrator of Economic Cooperation.

Probably in no field will his job be more complicated than in the case of petroleum equipment, regarding which he will have a lot of guesses but little real information. Something like $2,120,000,000 is to be put into petroleum facilities during the 4 years of the program, $860,000,000 of it to be furnished from the United States, but so far no definite list has been drawn up of the specific projects in which it will be used.

The administrator's difficulty in determining his recommendations for export of equipment to individual countries will be complicated by the necessity of matching those recommendations with requirements presented separately to the Department of Commerce, which sets the export quotas, by American companies operating abroad, whose material needs were totally ignored in the estimates of the Committee for Economic Cooperation.

The only estimates of American-company needs are those in the National Petroleum Council report on oil-industry requirements, but these do not cover one phase of activity which is highly important—European refineries owned jointly by American and native companies.

The whole job of administering the recovery program will be made harder by the extension of Soviet influence to additional European countries, which will necessitate extreme vigilance to insure that materials and commodities exported from the United States to both the Marshall plan countries and others, in Latin America for instance, are not transshipped behind the iron curtain.

Exaggerated, but True

RECENT charges that United States foreign policy is being made by the military are a little far-fetched, but it is safe to say they are being made by the State Department in cooperation with the armed services.

There is more truth than politics in assertions that Defense Secretary James V. Forrestal has had considerable influence on the administration's position on Middle East questions, and the military pressed strongly to have oil made a subject of discussion at the inter-American conference in Bogota, Colombia.

According to Thomas J. Hargrave, chairman of the Munitions Board, however, there is also a strong military interest in the conduct of our peacetime foreign trade, and particularly in exports of oil and other natural resources.

The board closely followed the drafting of the charter for the International Trade Organization and currently has a representative at Bogota to advise it concerning developments of military interest at that conference. Nearer home, the board is represented on the various interdepartmental committees dealing with foreign trade, among them the Committee on Trade Agreements and Reciprocity Information.

The objectives of the board in the field of foreign trade are to insure that controls over our trade with other nations provide adequate protection against diminishing our critical resources and to provide protection against increasing the war potential of possible enemies, Hargrave explained.

Another agency, the National Security Resources Board, also is interested in international matters as they affect its job of planning the industrial and civilian mobilization in the event of an emergency. Both the Munitions Board and the National

Security Resources Board were created under the National Security Act of 1947, which provides for unification of the armed services, the former being successor to the old Army and Navy Munitions Board.

Agreement Disagreement

MANY members of the oil industry are not yet convinced of a need for any agreement for allocation of product but the National Petroleum Council is expected to go along with Interior Department proposals for a voluntary agreement under Public Law 395 without demur.

Many men believe that the industry, which closed its eyes to the approaching emergency last year, now is fully awake and alert and can deal with any future difficulties without any formal arrangement, but most of them are willing to accept an agreement for two reasons. One reason is that in the event a quick, sharp increase in the armed forces imposes sudden new strains on the industry, the agreement will save it from public censure for any difficulty in meeting the situation. The other is a belief it would be foolish to scrap the machinery which proved so successful in meeting the fuel-oil shortage.

Suggestions that an agreement is unnecessary are supported to some extent by the statistics of the industry.

In December, when the industry woke up and got busy, stocks of the four major products were 15,120,000 bbl. under those of the corresponding date in 1946. As of this month, that situation had been almost exactly reversed and stocks were 15,169,000 bbl. ahead of the same time last year.

The industry is going into the driving season with some 113,000,000 bbl. of gasoline in inventories, some 8,000,000 bbl. more than a year ago, while crude runs to stills are 740,000 bbl. daily ahead of last year and gasoline production is up at least as much as the anticipated increase in demand.

The only bad spot in the picture is the Middle West. The increase in gasoline stocks is greatest on the Gulf and East coasts, with some increase on the Pacific Coast. The Rocky Mountain area is in good shape, but the Midwest is going into the summer season with stocks at about last year's level. It is expected, therefore, that some spot shortages may occur in that area, although if transportation can be made available from the Gulf refineries serious discomfort may be averted.

Continuous Compilation of All Oil Statistics Provided in House Bill

WASHINGTON.—Continuous compilation by the Bureau of Mines of all statistics pertinent to the production, refining, transportation and marketing of petroleum and natural gas is provided for in legislation introduced in Congress last week by Rep. John W. McCormack of Massachusetts, following the refusal of the House Appropriations Committee to give the bureau funds with which to undertake such work.

McCormack's bill authorizes an appropriation of $300,000 a year, although Interior Department officials figured originally that the job could be done for about a third of that amount.

Explaining his bill to the House, McCormack declared one of the great difficulties encountered in dealing with the fuel-oil shortage last winter was the lack of facts on the current and prospective supply-and-demand outlook.

The Government's normal peacetime service, he said, was never designed to meet the requirements of the new conditions which now prevail and "additional factual information is urgently needed to provide a broader base upon which intelligent policy may be founded and action taken to protect the public interest.

"At the present time many vital data are not available to the Government and as a result too often vital decisions on foreign and domestic policy and national defense are predicted on guesses when we should have the facts," he added.

Under the bill, the bureau would make such surveys and investigations as are necessary to secure current information on (1) available storage facilities, inventories, and sales of petroleum products of the marketing branch of the industry; (2) capacities and operations of transportation systems for petroleum, petroleum products, and natural gas, including pipe lines, tankers, barges, tank cars and trucks; (3) refinery capacities and operation, including sources of petroleum, and types and quantities of products; and (4) requirements of industry and the consuming public for petroleum products and natural gas. Such information would be published quarterly or oftener.

The bureau also would be directed to obtain such information concerning the petroleum industry outside the United States, including reserves, production, development, refining, transportation, and marketing, as may be deemed necessary for an evaluation of the effect of petroleum activities upon the peacetime economy and national security of the United States.

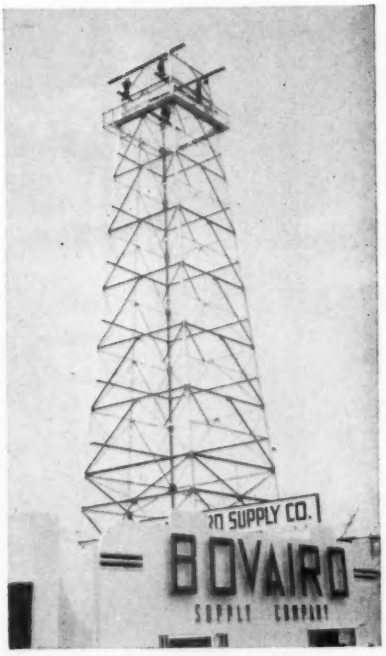
A.P.I. Group to Discuss Demand for Lubricants

The increased demand for lubricants, and particularly that of the military, will come in for considerable discussion at a meeting of the lubrication committee of the American Petroleum Institute to be held April 27-28 in the Mayo Hotel, Tulsa.

Speakers and their subjects will include Col. G. H. Vogel, of the Military Services Petroleum Board, on "The Armed Services' Present and Future Lubricant Requirements — Qualitative and Quantitative"; and A. J. McIntosh, Socony-Vacuum Oil Co., on "Production and Demand of Lubricants, Present and Future."

Following these talks will be a symposium on the activities and objectives of technical societies as related to lubricants and lubrication. Opening day of the meeting will be devoted to business sessions and registration.

I. P. E. RIG GOES UP



The 189-ft. rig pictured here under construction was being erected last week at the International Petroleum Exposition grounds in Tulsa as one of the exhibits for National Supply Co. Workmen are shown at the 154-ft. level. An 18-ft. gin pole, bringing total height to 207 ft., will be added. The rig, which was put up by Barney Duncan Rig Co., Ada, Okla., was completed the following day. Draw works and derrick machinery were being prepared to move in. The exposition will open May 15

HERE'S

PROOF...

PROOF OF THE SUCCESS OF THE U. O. P. IMPROVED FLUID CATALYTIC CRACKING UNIT FROM A STANDPOINT OF

OPERATION, MAINTENANCE, QUICK TURNAROUND

Placed in operation in June of last year, the U. O. P. designed fluid catalytic cracking unit at the Aurora Gasoline Company's Detroit refinery was shut down for turnaround after 176 days on stream. Normal operating and maintenance personnel accomplished the turnaround in only ten days . . . 4,508 man hours, which included thorough inspection and repairs of the cat cracker and all auxiliary equipment. Repairs and replacements were minor. And operating efficiency of the unit was calculated at 93 percent.

176 DAYS ON STREAM

10 DAYS TURNAROUND

4,508 MAN HOURS REQUIRED FOR TURNAROUND

93% OPERATING EFFICIENCY

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UNIVERSAL SERVICE PROTECTS YOUR REFINERY

Government Will Seek to Avert "Immediate" Tanker Shortage

WASHINGTON.—Plans for a ship-construction program which would include 170 high-speed vessels by 1951 in addition to those now under construction or planned, and toward which the Government would contribute $425,000,000, were disclosed last week by Secretary of the Navy John L. Sullivan.

The new program will be launched in the near future by a request by President Truman that Congress increase the original budget estimate of $39,500,000 to $100,000,000 for the coming fiscal year, $90,000,000 of which will be for starting new vessels and $10,000,000 for improving existing ones.

The plan to put American ship yards back into full operation was disclosed as the administration and Congress threw the preparedness program into high gear. Other developments of interest to the oil industry included committee approval of legislation which would require the registration of all men under 30 and provide for the drafting of men between the ages of 19 and 25, and an order by John R. Steelman, assistant to the President, to hold up the sale of all surplus war plants and production equipment for 30 days.

The merchant marine situation was discussed by Sullivan before the House merchant marine committee, with an explanation that the program he outlined represented the combined thinking and concurrence of the military establishment and has the approval of the President.

The Navy has 86 tankers and there are about 600 other ocean-going oil carriers owned by American citizens or considered to be under effective American control, comprising a total of 9,300,000 deadweight tons, about 11 per cent of this tonnage is over 20 years old, he said.

Estimated emergency requirements of the military services, compiled by the Armed Services Petroleum Board, indicate the United States would be short 116 vessels during the first year of an emergency, but aside from this, he told the committee, additional tankers will be required to meet increasing peacetime demands over and above any private building programs now projected in the United States or abroad.

By 1951, he declared, the presently planned increase of oil production in South America and the Middle East will require about 400 more tankers than are now available in the world's tanker fleet and, with allowance for obsolescence, the actual shortage will be about 520.

"Taking into account the 180 tankers now being constructed at home and abroad, there would be a total indicated world-wide tanker deficiency of about 340 ships," Sullivan said. "Should the United States' share of world tanker tonnage continue in the same ratio as at present (approximately one-half), the tanker-building program required by the United States to overcome its proportion of the deficiency indicated for 1951 would be 170 ships."

Tapline Would Cut Needs

Sullivan pointed out that if the Trans-Arabian pipe line is completed and kept in steady operation, future peacetime tanker needs would be reduced by approximately 80 vessels but, he added, "the one thing which is certain in the tanker picture is the fact that a tanker shortage of some proportions is immediately in prospect.

"To the extent that it may be possible to do so without endangering interests of national security, it is highly desirable that the tanker shortage be met by not interfering with the plans of industry to follow along the course on which it is now so encouragingly embarked," he said.

Sullivan emphasized that every effort must be made to persuade the industry to incorporate into new tankers features which will make them suitable for military use should such a need arise. Particularly, he said, new tankers should have a speed of 20 knots, which it is believed would be acceptable for commercial use, and the Government should assume the additional cost of $2,500,000 per vessel which this would entail.

This also would permit the construction of fewer ships than he had indicated, he explained, since a tanker of about 24,000 deadweight tons and a 20-knot speed, is equal in efficiency to 1.67 ships of the T-2 type.

Finding Oil?

ALL operators who discover oil start out with an inventory known as "undeveloped and prospective" acreage. These acreage holdings are the denominators in a formula that each operator uses in looking for future production, but they are not "common denominators" because some operators find more oil than others.

Is there any method for estimating the relative quantity of oil which an individual company may reasonably expect to find in the future? A consulting geologist, through a specially prepared review of certain aspects of oil exploration and an analysis of discovery statistics, attempts to answer these things and apply the solution to a group of 25 well-known oil companies . . . **See the article in next week's Journal.**

The Most Valuable Product?

Petroleum-and-natural-gas-derived chemicals sell by the pound and command the highest prices of any of the oil industry's products. With "petrochemistry" constituting the No. 1 upgrading of our industry's raw materials, the paper "Industrial Oxidation of Lower Aliphatic Hydrocarbons" by Joseph E. Bludworth, prominent petroleum and chemical consultant of Corpus Christi and Houston, has a definite dollars and cents background . . . **See next week's Journal.**

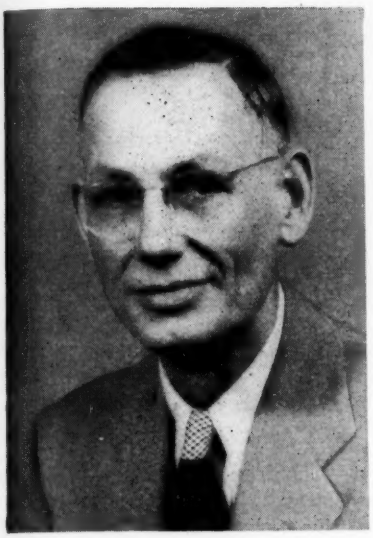
23,000 New Engineers a Year?

Kenneth B. Barnes, engineering editor, presents the final installment of The Journal's series on petroleum engineering schools, with complete roundup data on all U. S. engineering colleges as to faculty, current enrollment both undergraduate and graduate, degrees conferred, etc. . . . **Next week's issue.**

Oil-Industry Speakers Address A. I. M. E. Group

The Student Chapter of the American Institute of Mining and Metallurgical Engineers at the University of Texas continued its policy of inviting speakers from industry to give the members important information and hints which will be valuable when the petroleum engineering students graduate. Speakers for the first half of the current semester were Edward N. Jones, consultant from Pettus, Tex.; E. F. Stratton, exploration manager of Schlumberger Well Surveying Corp., Houston; M. E. Mitchell, Jr., engineer with Humble Oil & Refining Co., Houston; and C. O. Willson, editor of The Oil and Gas Journal, Tulsa.

PERSONALS



Former Bookkeeper, Now Head of Noble Drilling

C. C. FORBES, executive vice president of Noble Drilling Corp., Tulsa, has been named president of that company to succeed Lloyd Noble who has retired as head of a company he has directed for 27 years.

A native of Billings, Okla., Forbes joined Noble-Olson Drilling Co. in 1928 as a bookkeeper after graduating from the University of Oklahoma where he majored in accounting. In 1930 Noble and Arthur Olson, who had been partners since 1921, divided interests in their company and each formed his own drilling firm. Forbes remained with Noble.

At this time Noble had 15 drilling rigs. Forbes went with Noble as treasurer, and in 1936 was named vice president and treasurer. Three years later he was made executive vice president.

After 20 years of service with Noble, Forbes now heads a drilling company which has operated in 19 states, in England and in Canada. During the war in addition to an extensive drilling program in the United States the company also engaged in drilling projects in central England and the Northwest Territories.

In addition to the headquarters office at Tulsa, Noble Drilling also maintains offices at Houston, Fort Worth, Midland, New Orleans, and Casper, Wyo.

Lloyd Noble, president of Noble Drilling Corp., Tulsa, has retired after 27 years as head of the company. He will become chairman of the board of directors for Noble Drilling. **C. C. Forbes,** executive vice president, has been named to succeed Noble. **P. M. Johns,** treasurer of the company, will assume the additional duties of vice president; and **George Kemnitz,** who since 1943 has acted in the capacity of general superintendent of drilling operations, will be vice president in charge of drilling operations.

Elmer Ledbetter, of Wayne Oil Co., has been elected president of the Michigan Petroleum Association.

J. M. Norris, United Gas Pipe Line Co., has been transferred to Wichita Falls, Tex., from the company's New Orleans district, and promoted to district engineer.

Bob Sutton, formerly head of the land department of Ohio Oil Co., at Oklahoma City, has been transferred to Fort Worth. He has been succeeded by **D. L. Chapman.**

H. E. White, superintendent of Shell Pipe Line Co., has transferred from Houston to Healdton, Okla.

Henry Waters, formerly with Stanolind Oil Purchasing Co., has opened an office in Tulsa as representative of Northwestern Refining Co., St. Paul, Minn.

Dr. Carl Coke Rister, research professor at the University of Oklahoma, who is writing an oil history of the Southwest on a grant from Standard Oil Co. (N.J.), is in Washington to obtain historical material of the Petroleum Administration for War and of the industry during the war period.

A. C. Long, vice president of California-Texas Oil Co., Ltd., has returned to New York after a business trip to Europe.

Arnold V. Stubenrauch, manager of the systems and planning department for Sun Oil Co., has been named special assistant to **William D. Mason,** director in charge of the industrial relations department. **Walter F. Schneider,** of Sun' comptroller staff, has been named to succeed Stubenrauch.

G. R. Brainard, Jr., former district superintendent for Shell Oil Co., Inc., at Hobbs, N. M., resigned April 1 to become assistant division superintendent of drilling and production, Mid-Continent division, Seaboard Oil Co. of Delaware, with offices in Dallas. He is a graduate petroleum engineer, L.S.U., 1932. He was formerly associated with Ohio Oil Co. in East Texas.

Louis H. Zepfler, formerly technical assistant to **A. L. Wilson,** who recently retired as head of the steam and power department of the Bayway refinery of Esso Standard Oil Co., has been named to succeed Wilson. **Joseph F. Leddy, Jr.,** who has been on special temporary assignment in the mechanical department, was named technical assistant to Zepfler.

W. E. Nygren, exploration geologist with Richmond Petroleum Co., has been transferred from Colombia to western Venezuela, where he will be in charge of surface geological work. His headquarters will be in Maracaibo.

R. W. Heath, manager of Signal Oil Co.'s natural-gasoline department, has been made a director of the company. Heath is a former president of the California Natural Gasoline Association.

Austin T. Foster has been appointed general counsel and **Carl E. Kieser** has been named associate general counsel of Socony-Vacuum Oil Co., Inc. Former General Counsel **George V. Holton** is now board chairman. **Fontaine Martin, Jr.** and **Donald McLean** have joined Socony-Vacuum's law department.

W. L. Matjasic, formerly in the Bakersfield, Calif., geological office for Honolulu Oil Corp., has been placed in charge of the company's office in Los Angeles to replace **Howard Smith,** who has been transferred to the San Francisco office as head of the land and lease department. The Los Angeles office has been converted to a geological and land-acquisition office. Smith will retain his position as vice president of Industrial Research Laboratories, Ltd., a wholly-owned subsidiary.

Jim Hickey, formerly operating division manager of the East St. Louis refinery of Socony-Vacuum Oil Co., has been named operating superintendent of the company's products pipe line in Maine. Other changes at the company's East St. Louis refinery include **R. W. Fuhrhop,** formerly industrial relations manager, has been transferred to the Paulsboro, N. J., refinery to be head of industrial relations there. **N. J. Holten,** formerly assistant industrial relations manager, has been named to succeed Fuhrhop.

Dr. Sherman A. Wengerd, assistant professor of geology at the University of New Mexico, has been awarded a faculty senate research grant to complete a lithologic and economic study

Facts you should know about GOODALL FLEXO ROTARY HOSE AND REPAIR SERVICE

It is well established that Goodall Flexo Rotary Hose — with Barney Couplings — has the longest life of any rotary hose combination ever developed. In addition, Goodall maintains a repair department in Houston that further increases the service you get from this outstanding hose.

In the event that the hose ruptures behind the coupling — the most common cause for rotary hose replacement — it can be easily repaired at low cost by simply resetting the coupling in good hose. The loss in length may be as little as 18 inches. Sometimes this inexpensive repair job may save the hose several times before it finally becomes too short.

In case of damage near the center of the hose (or if the usable hose is too short) why not have the couplings reset in short lengths for use as vibrator hose at a considerable saving?

Then, when the hose is completely used up, the Barney Couplings still have a trade-in value. That's another important saving that makes Goodall the first-choice rotary hose.

Goodall is the only rotary hose manufacturer to offer such service. This service, combined with the advanced features of Goodall "Flexo" Rotary Hose and Barney Couplings make Goodall the favorite with oil companies and drilling contractors everywhere.

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DISTRIBUTORS: Texas and Louisiana—Houston Oil Field Material Co.—Wilson Supply Co. Oklahoma—Iverson Supply Company.

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FACTORY AT TRENTON, NEW JERSEY.

GOODALL FLEXO LONG LIFE Rotary Hose

of the Viola limestone in South Central Oklahoma. The study was begun in 1940 as a doctoral thesis.

Jerry Luboviski, former United Press correspondent, has joined the Western Oil and Gas Association as public-relations representative. He succeeds **John T. Synon,** who recently resigned.

Marcel Thomas, New York manager of Groupement d'Achat des Carburants (G.A.C.), has gone to Paris for a short business trip. G.A.C. is comprised of oil companies operating in France.

E. S. Carley has been named in charge of order and distribution for Anchor Petroleum Co., Tulsa. He succeeds **O. L. Ely** who was recently named manager of the West Coast division for the company, and the newly formed Los Angeles office placed under his direction. **J. G. Vlahos** has been named assistant to Ely.

E. L. Cralle, of Norman, Okla., has joined Cities Service Oil Co. as petroleum engineer at Oklahoma City.

Hines H. Baker, executive vice president, Humble Oil & Refining Co., has been appointed chairman of the 1948 national consolidation program of the National Association of Manufacturers.

Dean F. Metts, formerly assistant division geologist of the southwest Texas division for Humble Oil & Refining Co., has been appointed chief geologist of Chicago Corp.'s oil and gas division, with headquarters at the company's Corpus Christi, Tex., offices. He was southern district representative for the American Association of Petroleum Geologists from 1941 to 1943, and was president of the New Orleans Geological Society in 1943-44.

Kenneth W. Webb, formerly with Amerada Petroleum Corp., will join the geological staff of Deep Rock Oil Corp. May 1 at the company's Wichita office. Other personnel in the Kansas district include: **Walter D. Henderson,** geologist; **William C. Boyle,** landman; and **W. H. Pattison,** who will be in charge of the Wichita office.

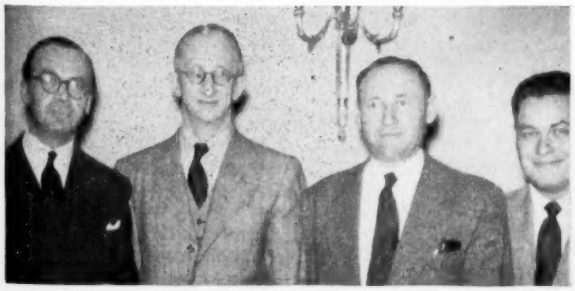
John A. Britton, Jr., vice president of Enjay Co., Inc., chemical-products marketing affiliate of Esso Standard Oil Co., has been elected president of that company. He has been associated with Standard Oil Co. (N.J.) and affiliated companies for 27 years. Britton succeeds **H. W. Fisher,** who will continue as a director of Enjay.

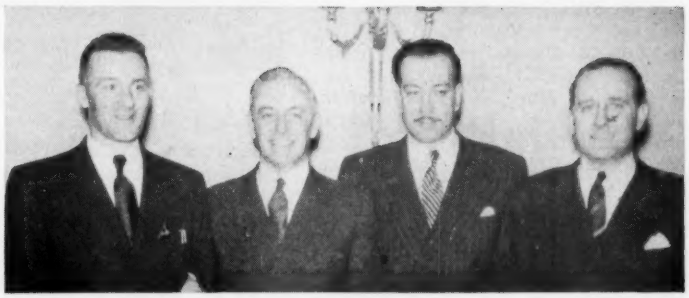
O. V. Tracy, assistant manager of Esso Standard's chemical-products department, has been elected a director of Enjay. Tracy joined the research department of Standard Oil Co. of Louisiana at Baton Rouge in 1930. He pioneered and has been continuously associated with the development of synthetic rubbers, alcohols, additives, and other chemicals, and until recently was manufacturing coordinator of such products for Esso Standard Oil Co. Tracy succeeds **Dr. H. G. Burks, Jr.,** who was recently appointed general manager.

Herman S. Foote, formerly assistant general superintendent of Interstate Oil Pipe Line Co.'s northern division, has been named district superintendent of the company's northwest district. He succeeds **Max B. Ederington,** who recently resigned to become superintendent of Andian National Corp., Ltd., in Colombia. Foote has been with Interstate for 28 years.

Frank Wallace, formerly drilling superintendent for Wilcox Oil Co. for 20 years, has joined Woods Drilling Co. as vice president in charge of drilling.

Four executives of Humble Oil & Refining Co. and one from Hughes Tool Co. have left Houston to attend the advanced management training course at Harvard Graduate School of Business in Cambridge, Mass. They are **O. W. Lomax,** vice president and general superintendent, Humble Pipe Line Co.; **Edwin W. Morris,** assistant industrial relations director, Hughes Tool Co.;





Foreign guests at the April meeting of the New York chapter of Nomads are shown in these photographs. Top left: D. G. Hitt, Anglo Iranian Oil Co., London; W. G. Nicholls, Kuwait Oil Co.; I. J. Teitelbaum, Argentine Government Oilfields (Y.P.F.); and C. B. O'Connor, Pan American Airways, Brazil. Top right: J. R. Simpson, Imperial Oil, Ltd.; C. A. Rodstrom, Arabian American Oil Co.; H. A. Gonzalez, Argentine Government Oilfields; and J. A. C. Armstrong, Imperial Oil, Ltd. Bottom left: L. Walker, Union Tractor & Equipment Co., Canada, and S. P. King, Creole Petroleum Corp., Venezuela. Bottom right: F. G. Cance, S.N. M.A.R.E.P., Paris, France; M. J. Galpin, Ideco-Clark, London, England; E. F. Fabres, Corporacion de Fomento, Chile; and M. Binet, S.N. M.A.R.E.P., Paris

PERSONALS

Frank A. Watts, sales manager, Humble Oil & Refining Co.; and **C. E. Reistle, Jr.,** manager of Humble's production department.

Fred Allgaier, resident inspector for Bayou Pipe Line Co. at its Baytown, Tex., station since 1942, has been transferred to Port Neches, Tex., and promoted to resident chemist.

Earle Shamblin, geologist, and **H. L. Stegall,** landman, have been transferred by Deep Rock Oil Corp. from Shreveport to San Antonio. Deep Rock has closed its office in Shreveport to open a Southwest Texas office in San Antonio.

G. H. McKay has resigned as vice president in charge of sales of Tennessee Gas Transmission Co., Houston, to become executive vice president of East Tennessee Natural Gas Co., Chattanooga.

Harold L. Sullivan, former president and manager of Loffland Brothers Drilling Co., Tulsa, has been named president and chief operating officer of the recently organized Zephyr Corp., Tulsa, a new $1,000,000 firm under the laws of Oklahoma, to actively engage in the operation of rotary drilling tools. The newly organized company will be a separate company from Zephyr Drilling Co., Tulsa. Other officers and directors of the new company include: **F. G. McClintock,** vice president, and **S. C. Canary,** vice president and treasurer, both of whom have been active heads of Zephyr Drilling Co. for the past 11 years; and **J. M. Winters, Jr.,** secretary. Additional directors are **R. Otis McClintock,** president of First National Bank & Trust Co., and **J. I. Hull,** general superintendent of the Zephyr Drilling Co. at Pauls Valley, Okla.; and **Douglas B. Wright,** assistant secretary-treasurer.

SHIFTS—

R. N. Bills, geologist, Amerada Petroleum Corp., Victoria to Beeville, Tex.; **B. M. Choate,** geologist, Atlantic Refining Co., Lake Charles, La., to Jackson, Miss.; **W. E. Shamblin,** geologist, Deep Rock Oil Corp., Shreveport, La., to San Antonio, Tex.; **W. A. Crary,** foreman, Sinclair Prairie Oil Co., Carmi, Ill., to Henderson, Ky.; **W. W. Humphries,** superintendent, J. R. Sharp Drilling Co., Marshall, Tex., to Alexandria, La.

Carl L. Mantzel, engineer, Magnolia Petroleum Co., Dallas to Premont, Tex.; **Paul N. Hunt,** engineer, The Texas Co., Port Neches, Tex., to Woodbury, N. J.; **O. I. Jantz,** foreman, Amerada Petroleum Corp., Hazelhurst, La., to Hattiesburg, Miss.; **H. C. Hall,** foreman, Stanolind Oil & Gas Co., Chandler to Oklahoma City; **Edward H. Kunkel,** engineer, Carter Oil Co., Pauls Valley to Oklahoma City; **Charles F. Redmon, Jr.,** engineer, The Texas Co., Fort Worth to Houston, Tex.

John R. Stockton, engineer, Stanolind Oil & Gas Co., Odessa to Sundown, Tex.; **C. E. Stanley,** superintendent, Humble Oil & Refining Co., Van to Thompsons, Tex.; **Bowmar Waters,** superintendent, Claude Bell Oil Co., Gainesville to Eastland, Tex.; **Frederick L. Converse,** engineer, Stanolind Oil & Gas Co., Andrews to Fort Worth, Tex.; **Boyd C. McRee,** engineer, Union Producing Co., Beeville, Tex., to Shreveport, La.; **A. E. Benson,** foreman, Amerada Petroleum Corp., Colorado City, Tex., to Scott City, Tex.

W. E. Harris, superintendent, Humble Pipe Line Co., Corpus Christi to San Antonio, Tex.; **Paul M. Bennett,** engineer, Atlantic Refining Co., Dallas, Tex., to Great Bend, Kans.; **E. H. Shannon,** foreman, The Texas Co., Waco to Houston; **J. M. Meyers,** foreman, Helmerich & Payne, Inc., Wichita Falls to San Angelo, Tex.; **Thomas Ng,** engineer, Standard Oil Development Co., Elizabeth, N. J., to Baton Rouge, La.; **Robert A. Patterson,** engineer, Houdry Process Corp. of Pennsylvania, Marcus Hook to Lansdown, Pa.

Robert H. Gallaher, Jr., engineer, The Texas Co., Rangely, Colo., to New Castle, Wyo.; **Charles M. Hartwell,** engineer, Cities Service Oil Co., Oil Hill, Kans., to Odessa, Tex.; **F. M. Beal,** engineer, Carter Oil Co., Norman to Purcell, Okla.; **H. M. Mays,** foreman, Wilcox Oil & Gas Co., Stroud to Pauls Valley, Okla.; **G. D. Chastain,** superintendent, Michigan-Ranger Oil Co., Ranger to San Antonio, Tex.; **Charles A. Steen,** geologist, Stanolind Oil & Gas Co., San Antonio to Houston.

Joe Karbosky, engineer, Phillips Petroleum Co., Borger, Tex., to Bartlesville, Okla.; **Tom Gaines,** engineer, The Texas Co., Daisetta to Houston, Tex.; **Lloyd F. Carter,** superintendent, Carl Short, Inc., Houston to Yoakum, Tex.; **A. C. Hart,** chemist, Sinclair Refining Co., Houston to Pasadena, Tex.; **Louis O. Storn,** engineer, Shell Oil Co., Inc., Odessa, Tex., to Hobbs, N. M.; **Joseph Nalle,** superintendent, Teci Production Co., Shamrock to Houston, Tex.

H. K. Herr, foreman, Kerr-McGee Oil Industries, Inc., Mansfield, La., to Sweetwater, Tex.; **J. T. Gilliam,** foreman, Amerada Petroleum Corp., Plaquemines to Crowley, La.; **J. W. Dix,** engineer, Barnsdall Oil Co., New Orleans to Arcadia, La.; **Robert B. Chapman,** engineer, Carter Oil Co., Effingham, Ill., to Tulsa.

DEATHS

Delmar C. Harmon, who resigned about a year ago as production superintendent of McCarthy Oil & Gas Corp., died April 2 in Houston. He was with McCarthy about 2 years and with Stanolind Oil & Gas Co. 21 years previously.

Patrick Treanor, formerly a director of Mill City Oils, Ltd., and active in the early Turner Valley development, died recently at Calgary.

Joseph T. Lantry, 62, civil engineer who had been active in the laying of pipe lines for several oil companies, died April 6 in Tulsa.

Bertrum B. Bullard, 72, retired oil operator who came to Houston about a year ago from Wichita Falls, Tex., died April 8 in Houston.

Leon H. Marsh, vice president and secretary of Kennedy Valve Manufacturing Co., Elmira, N. Y., died recently.

Augustus M. Slack, 70, of Millarville, Alta., died recently at Calgary. A native of the Petrolia oil area in Ontario, he drilled in Borneo, Egypt, and New Zealand before moving to Alberta 30 years ago.

Reuben A. McLeod, 87, retired oil operator who had done drilling work in the upper Gulf Coast area for nearly 35 years, died April 7 in Houston.

Stephen R. Zagst, 76, retired rig-building contractor who had operated in various Gulf Cost fields in the early 1900's, died April 6 in Houston.

Joseph M. Lundquist, lubrication engineer in the Chicago division and a 25-year veteran with Continental Oil Co., died recently in Chicago.

Robert H. Bowles, 52, president of Cimarron Petroleum Co., Long Beach, Calif., died April 11 in San Francisco.

Joseph B. Rayfield, 46, operating supervisor of Lone Star Gas Co.'s East Texas district of production, died recently in Dallas.

P. W. Appleby, oil operator in the Permian Basin, died April 8 in Tucson, Ariz.

New Low-Cost Welder has Wide Utility for Field Construction and Maintenance

By W. R. PERSONS, Sales Mgr.
THE LINCOLN ELECTRIC COMPANY
CLEVELAND 1, OHIO

THE cost-cutting advantages of arc welding have now been extended to a multitude of field construction and repair jobs by a new Lincoln Engine Driven Welder which sells for only $400. Weighing only 660 lbs. and occupying a space less than 2 ft. by 4 ft., it can be placed in a pick-up truck for welding service anywhere. With a welding current range of 40 to 250 amperes, it provides ample power for easy welding of all kinds in the shop or in the field where electric power is not available and where the operating factor is not high.

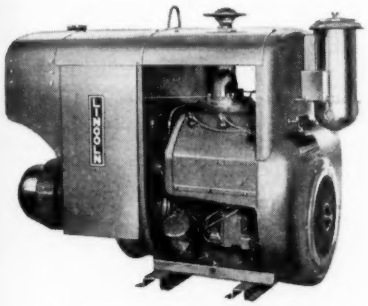


Fig. 1. New low-cost, light-weight Model S-3695 Lincoln Welder.

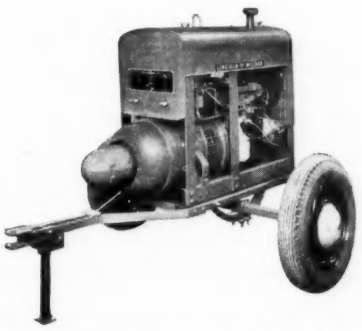


Fig. 3. Portable 200-amp. model S-6090 Lincoln Welder, side panel removed.

Versatile. The D.C. output of this welder enables you to weld all essential metals and alloys easily, speedily. It simplifies the repair of broken parts, reclamation of worn parts by hard-facing, fabrication of containers and building of special equipment and structures of all sizes and types.

No coolant to worry about. The unit is powered with a 4-cylinder, V-type, air-cooled 22 hp. engine. No anti-freeze is required in the winter.

Portable or stationary. This new Lincoln, known as the "Type S-3695," can be supplied in the stationary model shown in Fig. 1 (price $400, freight prepaid) or with two-wheel, pneumatic-tired running gear at extra cost.

Other Lincoln models. The new light-weight S-3695 joins the ranks of these other Lincoln Engine Driven Welders which are serving industry throughout the world.

S-6090. Heavy-duty 200-amp. welder with 29-hp. water-cooled engine. Thousands are in use on pipe lines and construction projects. See Fig. 3.

Fig. 2. The new welder is being used extensively for jobs such as this flange fitting.

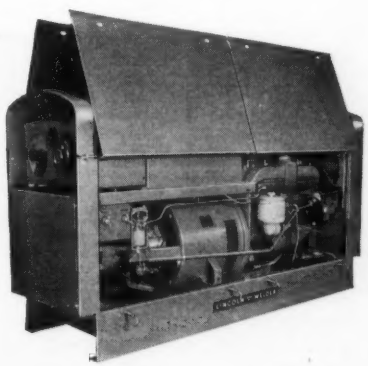


Fig. 4. 400-amp. Model S-7065 Lincoln Welder.

S-7065-6. Heavy-duty 300 and 400-amp., gasoline engine driven welders with Dual Continuous Control. Six-cylinder, 63 hp. engine. See Fig. 4.

Similar Lincoln welders are also available with Diesel engines.

The above is published by LINCOLN ELECTRIC in the interests of progress. For details on new low-cost welder, write for copy of Bul. 367. The Lincoln Electric Company, Dept. 222, Cleveland 1, Ohio. **Advertisement**

Nitrogen Removal from Natural Gas

PART 1

A background in air and other low-temperature separation methods and gas dehydration, and carbon dioxide and hydrogen sulfide removal

by W. W. Deschner and W. W. Bodle

THERE were 4,400 billion cubic feet of natural gas[2] marketed during 1947. This volume exceeded by 10 per cent the sales of natural gas during 1946. Increased cost of solid fuels and a high level of business activity have contributed to a constant rise in the use of natural gas.

Present demands for natural gas are rapidly depleting the reserve of nitrogen-free gas. This fact, together with improved prices at the well, is making natural gas of high nitrogen content a more valuable natural resource.

High-nitrogen natural gas, however, presents some problems to consumers and transmission facilities. The diluent nitrogen has the effect of reducing the capacity of transmission lines. The reduction in pipe-line capacity is sufficiently serious that the economics of nitrogen removal are being seriously considered.

W. W. DESCHNER

W. W. BODLE

Deschner, manager of the chemical division of J. F. Pritchard & Co., Kansas City, Mo., since 1942, graduated from Washburn College (B.S. in chemistry), and then took his Ph.D. in chemical engineering from University of Michigan. His earlier industrial connections were with Corn Products Refining Co. and Standard Oil Co. (Ind.). He also taught chemical engineering at Pratt Institute (Brooklyn) and at University of Kansas.

Bodle received his B.S. degree in chemistry from Yale University in 1936 and a master's degree in chemical engineering from New York University in 1940. He was employed by M. W. Kellogg Co., 1936-1946. He has been with J. F. Pritchard & Co. since 1946 in the capacity of assistant manager of the Chemical Division.

The inert nitrogen does not cause serious difficulty to the consumer interested in generating heat other than to reduce the efficiency of the heat-generating process and tend, perhaps, to require burner readjustments. This is not true in all cases of the consumer who utilizes natural gas as a source for carbon and hydrogen in the production of chemicals. Present-day processes utilize the following reactions for production of synthesis gas:

$$3CH_4 + CO_2 + 2H_2O \rightarrow 4CO + 8H_2 - \text{heat} \quad (1)$$

$$2CH_4 + O_2 \rightarrow 2CO + 4H_2 + \text{heat} \quad (2)$$

It may be seen that any nitrogen concentration in the natural gas will give a lower concentration of nitrogen in the crude synthesis gas if the process is carried out according to either reaction above.

Methanol Synthesis

Approximate losses of reactive gas have been estimated for the methanol

TABLE 1*—APPROXIMATE AVERAGE NITROGEN CONTENT OF NATURAL-GAS RESERVES OF THE UNITED STATES

	Proven reserve[1] (trillion cu. ft.)	Average nitrogen content (per cent)	No. of samples
District 1:			
Appalachian area[2]	5.000	6.5	207
District 2:			
Kansas	10.940	...	....
Hugoton field[3]	10.000-15.000[4]	16.3	20
All others	.....	12.5	378
Oklahoma	6.122	...	....
Hugoton field (Texas Co.)	7.600[5]	16.3	10
All others	.....	6.2	343
District 3:			
Arkansas	0.978	3.4	38
Louisiana	17.212	3.6	95
Mississippi	0.952	2.4	6
New Mexico	2.408	4.6	80
Texas	82.033	...	....
Panhandle[6]	25.000[7]	11.3	392
West Texas[8]	6.400[7]	4.0	34
Central Texas[9]	0.900[7]	8.5	67
East Texas[10]	8.000[7]	3.5	22
Gulf Coastal region[11]	34.000[7]	2.4	69
Colorado	0.100	4.6	60
Montana	1.224	4.6	88
Utah	0.100	3.8	13
Wyoming	0.828	4.6	155
District 5:			
California	12.962	4.9	56
Total United States	140.859	7.9	2,120

*This table was prepared by and is published with the permission of the U. S. Bureau of Mines.

[1]Natural Gas Reserves by E. DeGolyer, The Oil and Gas Journal, Vol. 44, No. 52, May 4, 1946, pp. 80-82. [2]Ohio, Pennsylvania, Kentucky, Tennessee, and West Virginia. [3]Counties of Finney, Grant, Haskell, Kearney, Morton, Seward and Stevens. [4]Testimony of witnesses before FPC hearings at Kansas City, Kans., September 1945 and Oklahoma City, October 1945. [5]From testimony of Elmer Capshaw, gas engineer, Oklahoma Corporation Commission before FPC hearing, Oklahoma City, October 10, 1945. [6]Counties of Carson, Gray, Hartley, Hutchinson, Moore, Potter, and Wheeler. [7]Future Outlook for Gas Transmission Lines by M. L. Mayfield, The Petroleum Engineer, Vol. 17, No. 8, May 1946, pp. 59-68. [8]Counties of Andrews, Crane, Ector, Gaines, Loving, Pecos, Upton and Ward. [9]Counties of Baylor, Brown, Clay, Coleman, Comanche, Eastland, Erath, Fisher, Jack, McCullough, Palo Pinto, Shackelford, Stephen, and Young. [10]Samples from counties of Anderson, Cass, Gregg, Harrison, Houston, Marion, Panola, Rusk, Van Zandt, and Wood. [11]Samples from counties of Bee, Brazoria, Brooks, Chambers, Duval, Fort Bend, Jackson, Jim Hogg, Jim Wells, Live Oak, Nueces, Refugio, San Patricio, Starr, and Victoria.

synthesis according to the following conditions:

Synthesis gas production	Reaction No. 1
Synthesis temperature	662° F.
Synthesis pressure	5,100 psia.
Methanol condensation at reactor outlet	100 per cent
N_2 in natural gas	20 per cent
N_2 estimated in synthesis gas	6 per cent
N_2 in condensed liquid	0 per cent
Approach to equilib conc. of methanol at reactor outlet	30 per cent

	Per cent N_2 in reactor inlet gas		
	10	20	30
Per cent methanol in reactor outlet gas (equilib conc.)	32.8	24.8	18.0
Per cent methanol concentration in reactor outlet	9.85	7.5	5.4
Per cent nitrogen in vent gas	13.40	24.8	35.5
Mols vent gas/100 mols synthesis gas	44.8	24.2	16.9
Mols reactive gas lost per 100 mols feed gas	38.8	18.2	10.9
Per cent reactive gas lost through vent	41.4	19.3	11.6

The figures show that methanol production per pass decreases as the nitrogen content of reactor inlet gas increases. They also indicate marked increase in gas venting when nitrogen in reactor inlet gas decreases. The nitrogen diluent, therefore, causes either recirculation of larger quantities of gas to reactor inlet or venting of considerable quantities of reactive gas.

Nitrogen Content of Gas

Some of the large natural-gas reserves in the United States are high in nitrogen gas content. Table 1[15], which was prepared by P. V. Mullins of the U. S. Bureau of Mines, outlines the important natural-gas reserves together with their average nitrogen gas content.

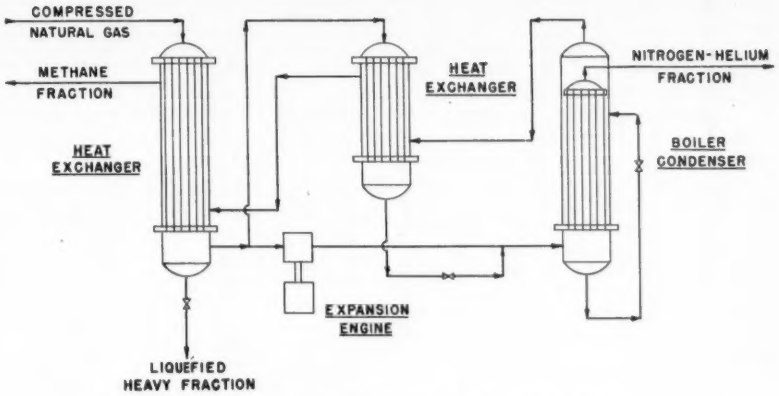


Fig. 2—Claude system for treatment of natural gas

Removal of Nitrogen

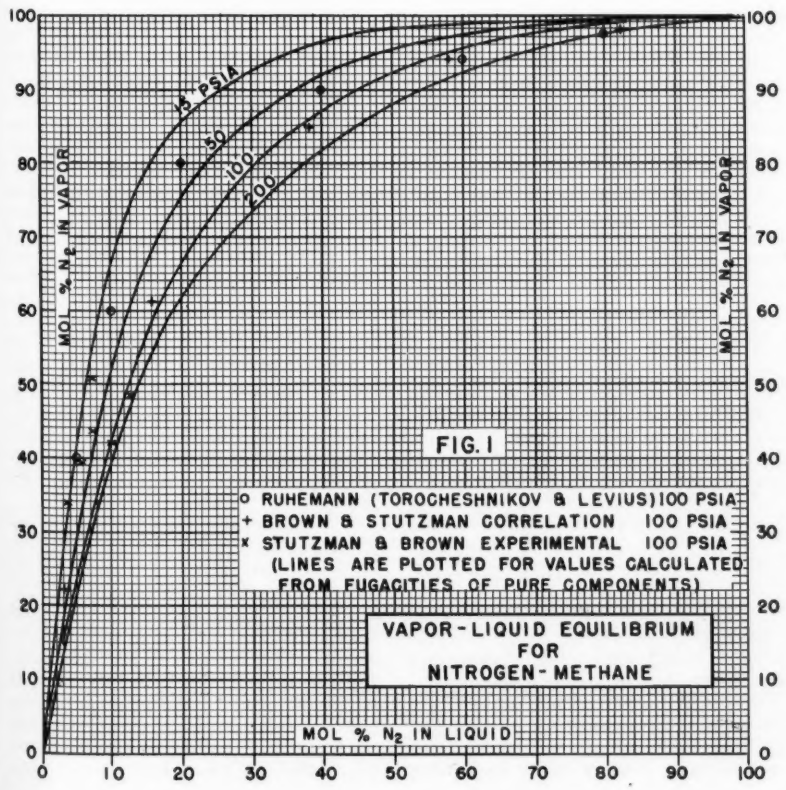
Several approaches to the problem of removing nitrogen from natural gas are logical. Among these are (1) low-temperature liquefaction with fractional distillation; (2) absorption in selective solvents such as hydrocarbons, water, or other inorganic or organic liquids; and (3) adsorption on selective solid bodies. Absorption and adsorption find their application generally in removing small amount of materials contained in large streams, the bulk of which does not attach itself readily to the absorption or adsorption medium. In the case of nitrogen in natural gas, nitrogen will rarely be found in concentrations higher than 30 per cent. Since nitrogen is the most volatile component in the natural gas it will, in general, be the least readily absorbed so that such a process must suffer from the fact that the large bulk of material, methane and heavier hydrocarbons, must be absorbed and subsequently stripped from the absorption medium. Adsorption processes suffer similarly.

Fractional distillation.—This is the most generally used method for separation of mixtures and, as may be seen from vapor-liquid equilibrium diagram, Fig. 1, is applicable to mixtures of nitrogen and methane. However, if separation into pure components is to be effected, temperatures below the critical temperature of the more volatile component must be attained. The critical temperature of nitrogen is —233° F.

The main problems in fractional distillation of nitrogen-methane mixtures are to cool the gases to low temperature, maintain the system at low temperature, and produce liquid for reflux at low temperature. These problems are not difficult to overcome. Several industrial processes for gas separation by fractional distillation at low temperature will be described briefly to introduce techniques used.

Claude system.—This system, for treating natural gas whereby a separation into fractions of helium and nitrogen, methane, and heavier hydrocarbons is effected, has been described by G. Claude[1]. Claude's system depends for refrigeration on the effect of passing compressed gases through an expansion engine with performance of work. Hydrocarbons heavier than methane are condensed out and removed from the system as liquid. Methane is condensed out and subsequently evaporated, emerging from the apparatus as a gas. Helium and nitrogen remain uncondensed and also leave the system as gases. The methane and nitrogen-helium streams serve to precool incoming feed gas before it enters the expansion engine.

No rectification tower is employed in this system so that the products obtained are necessarily impure and the loss of methane in the effluent


MOL % N2 IN VAPOR
MOL % N2 IN LIQUID
15 PSIA
30
100
200
FIG. 1
o RUHEMANN (TOROCHESHNIKOV & LEVIUS) 100 PSIA
+ BROWN & STUTZMAN CORRELATION 100 PSIA
x STUTZMAN & BROWN EXPERIMENTAL 100 PSIA
(LINES ARE PLOTTED FOR VALUES CALCULATED FROM FUGACITIES OF PURE COMPONENTS)
VAPOR-LIQUID EQUILIBRIUM FOR NITROGEN-METHANE

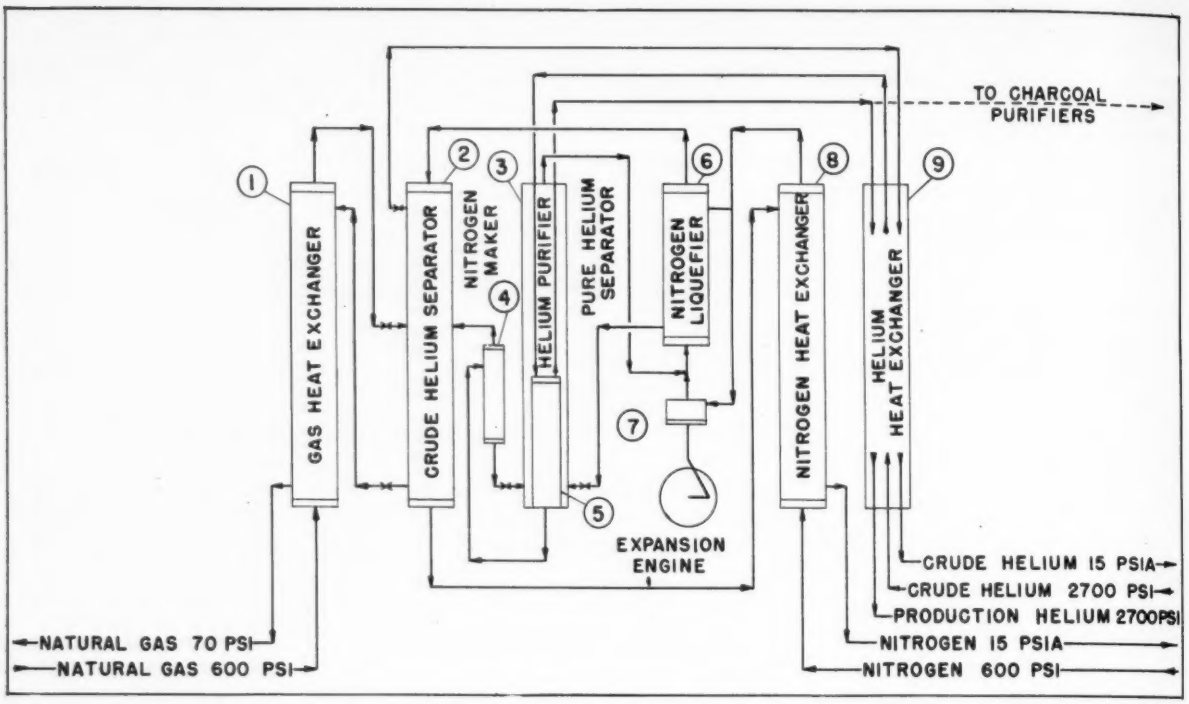


Fig. 3—Simplified diagram of Bureau of Mines helium separation and purifications cycles

nitrogen-helium stream may be considerable.

A schematic flow diagram of Claude's system is shown in Fig. 2.

Many of the features of low-temperature gas separation are illustrated by plants designed for the separation of hydrogen from coke-oven gas. Such plants have been used for production of synthesis gas for ammonia production.

Coke-oven gas.—Ruhemann[19] describes two types of plants for separation of coke-oven gas. The simplest of these two types the so-called Claude or "Air Liquide" process is designed to produce rather impure product gas since the Claude ammonia synthesis takes place under such high pressures that the catalyst is less sensitive to impurities.

The Claude system for coke-oven gas separation distinguishes itself primarily in the fact that expansion engines are employed for refrigeration and use of external refrigeration is not required.

The separation of coke-oven gas resolves itself primarily into the separation between nitrogen and methane to produce a nitrogen-hydrogen fraction and one or more fractions composed of methane and heavier components along with carbon monoxide. The separation required is comparatively easy and therefore it is not necessary to employ a fractionating column in the process. Sufficiently good separation is achieved by a series of condensation steps followed by separation of the liquid fraction containing the higher-boiling components prior to further condensation.

The separation of helium from natural gas is an important low-temperature gas-separation process. At present this is the only source of helium.

The helium-recovery system employed by the U. S. Bureau of Mines has been outlined by Seibel[20] and described in detail by Mullins[14].

B. of M. System

In the Bureau of Mines system[14], natural gas containing about 1 per cent helium is obtained at pipe-line pressure of about 600 psig., or compressed to that pressure. After removal of carbon dioxide by scrubbing with caustic or ethanolamine solution and drying with solid adsorbent, the gas enters the cold apparatus shown on the flow sheet, Fig. 3[14]. The inlet gas is cooled to about —220° F., in the gas heat exchanger and then enters the crude-helium separator which is held at about 250 psig. About 2 per cent of the incoming stream remains uncondensed at this point and contains practically all of the helium plus an equal quantity of nitrogen. This crude helium leaves the top of the separator and is taken to a gas holder. Condensed liquid which is natural gas free of helium passes from the crude-helium separator outward through the gas heat exchanger, thereby cooling incoming gas.

Crude helium produced from the above step is taken from the gas holder, compressed to 2,700 psig. and cooled in the helium heat exchanger. The crude helium then enters the pure-helium separator where nitrogen is condensed out at 2,700 psig. and —310° F. by heat transfer to boiling nitrogen at essentially atmospheric pressure which surrounds the pure-helium separator. The uncondensed portion of the crude helium is commercially pure helium and is removed from the system at high pressure.

Liquid nitrogen which surrounds the pure-helium separator is obtained from a stream of nitrogen which is compressed at atmospheric temperature to 600 psig., condensed in the nitrogen liquefier and then allowed to boil at low pressure and about —320° F., around the pure-helium separator. The condensation of nitrogen at 600 psig. in the nitrogen liquefier is brought about by heat exchange with low-pressure nitrogen vapors which boil off the pure helium separator and with a portion of the 600-psig., nitrogen which passes through an expansion engine after leaving the nitrogen heat exchanger.

Separation of Ethylene

The separation of ethylene from cracker gases containing hydrogen and methane and various hydrocarbons heavier than ethylene is another important process to which low-temperature fractionation has been applied[17, 19].

Pratt & Foskett[17] describe a process for separating ethylene at relatively high pressure (600 psig.) using external refrigeration systems for condensation of reflux streams. A propane or ammonia refrigeration system is utilized for high (30° F.) and intermediate (—15° F.) level refrigeration and an ethylene plus propane or ammonia system for low-level refrigeration which is at —150° F. at the pressure mentioned. Reboiler heat is supplied

to the fractionating columns by low-pressure steam or hot water.

Ruhemann[19] describes a process for separating ethylene which does not require external refrigeration. Liquid fractions boiling at low temperature are used to condense gases for reflux. A circulating stream of ethylene taken off the product line is compressed and condensed to serve as reflux to the final distillation column which operates at essentially atmospheric pressure producing pure ethylene overhead at about —155° F. No steam or hot water is used for reboiling, because heat is supplied to reboilers by incoming gas streams which are condensed.

The most widely used process employing very low temperatures is that for fractionation of air. In 1946 it is reported[4] that approximately 11 billion cubic feet of high-purity oxygen was manufactured in 228 plants in the United States. Air separation has been extensively used in Germany for the production of nitrogen to be used in synthesis of ammonia.

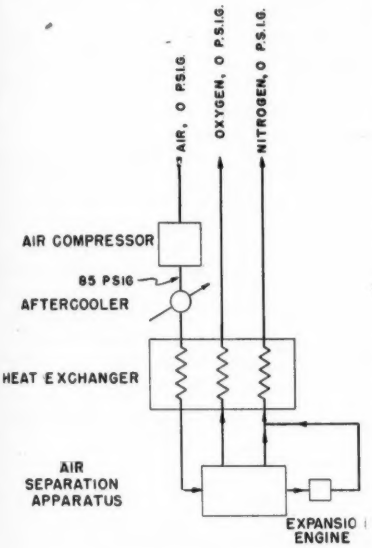


Fig. 4A—(Above) Joule-Thomson refrigeration cycle in air-separation plant. Fig. 4B—(Below) T-H diagram for air

Use of Refrigeration

Many of the refrigeration principles employed in air fractionation are common to all low-temperature operations and will be reviewed in some detail since they can easily be adapted to the problem of nitrogen separation from natural gas.

Attaining low temperatures and maintaining them at operating levels is of primary importance in all subatmospheric temperature work. The temperature of the equipment must first be reduced and then, due to influx of heat from the atmosphere, refrigeration must be supplied continually to maintain equilibrium.

Refrigeration methods may be divided into two classifications, viz. internal refrigeration and external refrigeration. Internal refrigeration is achieved by utilization of one of the process streams, either the feed or one of the effluent streams, as a refrigerant. External refrigeration depends upon a refrigeration system independent of the processing system. Both methods are utilized in air-separation systems described later.

The simplest type of air-fractionation plant, illustrating the internal-type refrigeration system, is the so-called Linde type, outlined to show how refrigeration is obtained in Fig. 4A. Refrigeration is obtained here by the throttled expansion through a valve of highly compressed air whereby Joule-Thomson type cooling takes place.

Air is compressed to a sufficiently high pressure to give the necessary Joule-Thomson effect. This pressure, in the usual size plants employing this system, is about 700 psi. as shown on the flow sheet. This pressure will be higher for smaller plants and slightly lower for larger plants. During the cooling-down period, pressures of about 1,500 psi. are common.

The air, after passing through the compressor aftercooler, is cooled in a heat exchanger by oxygen and nitrogen which leave the plant at low pressure and is then throttled to low pressure through an expansion valve causing its temperature to decrease. This colder low-pressure air then serves to cool incoming air to lower temperatures until finally, on passing through the expansion valve, a portion of the air is liquefied. When

(Continued on page 115)

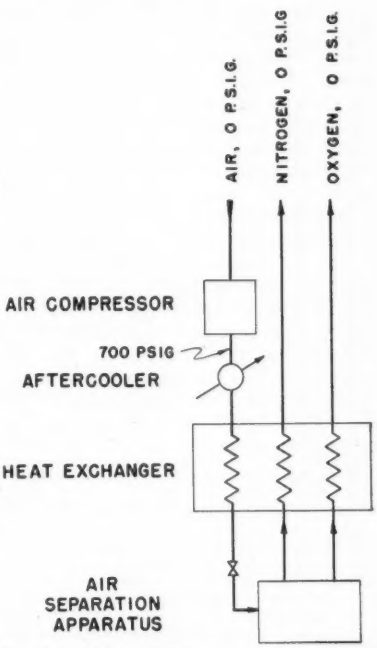
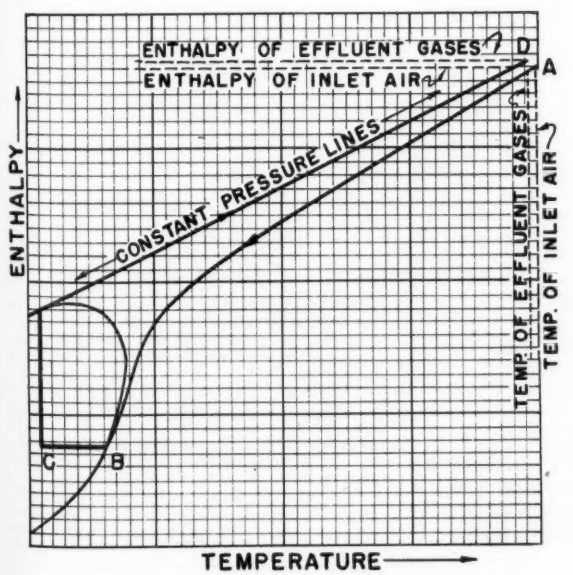
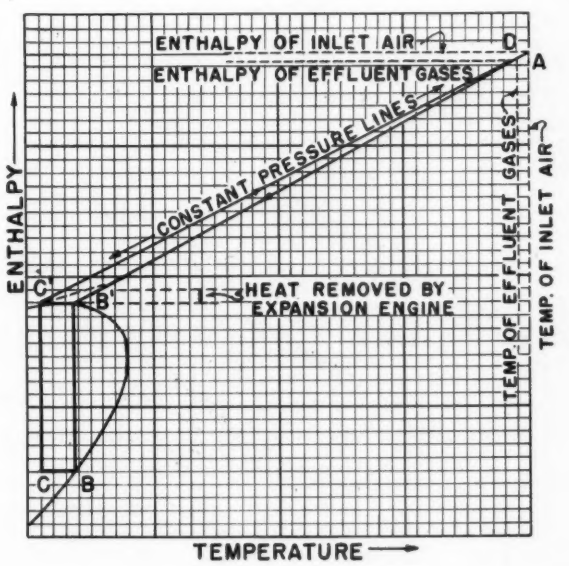


Fig. 5A—(Above) Expansion engine refrigeration cycle in air-separation plant. Fig. 5B—(Below) T-H diagram for air





Positive-Displacement Metering and Gravimetric Meter Proving

. . . on Crude-oil pipe lines

by J. B. Smith*

DURING the past 3 years The Standard Oil Co. (Ohio) has been metering crude oil in a pipe-line installation. Positive-displacement meters, which are proved gravimetrically, are used. The experiment has been successful and considerable data has been collected.

In this report about the experiment, the installation is described, operating procedures are outlined, some data relative to costs are given, and information concerning the accuracy of measurement which was achieved is given.

TODAY positive-displacement metering is the most generally accepted method of measurement used by the products pipe-line operators. Small-capacity meters are also used for measuring crude oil as it is produced at the wells, but very few, if any, larger-capacity positive-displacement meters have been installed on crude-oil pipe lines.

The measurement, by tank gages, of crude oil moving through pipe lines is unquestionably accurate and reliable when properly controlled. Years of use have proved this. This fact has no doubt inhibited the development and adoption of p.-d. metering for crude-oil pipe-line use. On the other hand, p.-d. metering has proved to be accurate and reliable after several years of use by products pipe lines.

*The Standard Oil Co. (Ohio), Cleveland.

Positive-displacement metering has two important advantages over tank measurements:

1. Oil-handling losses are appreciably reduced.

2. Installation costs may be lowered by using fewer tanks.

Handling losses are reduced because the oil quite often can be pumped directly onward, after being metered, without requiring temporary storage in tanks. Tank filling, breathing, and leakage losses are thereby eliminated. Another loss eliminated with some crudes is that due to a gradual deterioration caused by the stratification and settling out of heavier parts. With such crude oils a slowly growing layer of extremely heavy oil of in-

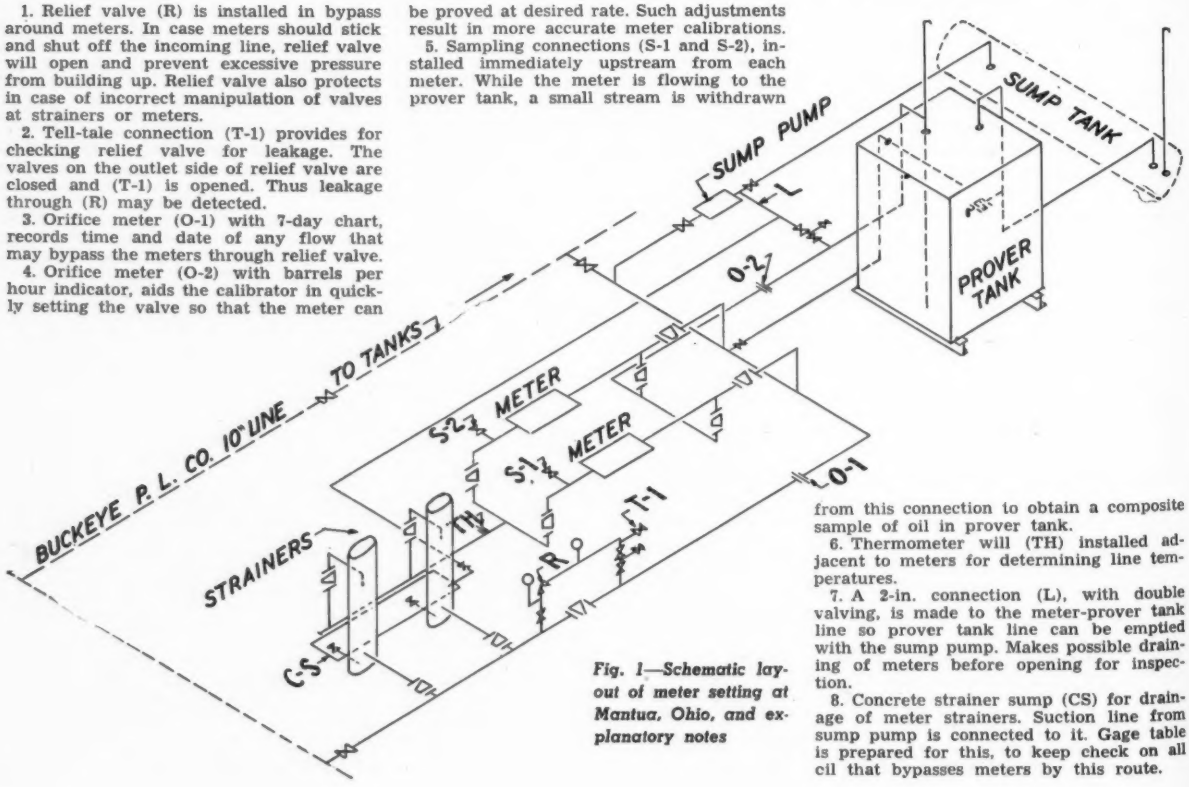


Fig. 1—Schematic layout of meter setting at Mantua, Ohio, and explanatory notes

1. Relief valve (R) is installed in bypass around meters. In case meters should stick and shut off the incoming line, relief valve will open and prevent excessive pressure from building up. Relief valve also protects in case of incorrect manipulation of valves at strainers or meters.

2. Tell-tale connection (T-1) provides for checking relief valve for leakage. The valves on the outlet side of relief valve are closed and (T-1) is opened. Thus leakage through (R) may be detected.

3. Orifice meter (O-1) with 7-day chart, records time and date of any flow that may bypass the meters through relief valve.

4. Orifice meter (O-2) with barrels per hour indicator, aids the calibrator in quickly setting the valve so that the meter can be proved at desired rate. Such adjustments result in more accurate meter calibrations.

5. Sampling connections (S-1 and S-2), installed immediately upstream from each meter. While the meter is flowing to the prover tank, a small stream is withdrawn from this connection to obtain a composite sample of oil in prover tank.

6. Thermometer will (TH) installed adjacent to meters for determining line temperatures.

7. A 2-in. connection (L), with double valving, is made to the meter-prover tank line so prover tank line can be emptied with the sump pump. Makes possible draining of meters before opening for inspection.

8. Concrete strainer sump (CS) for drainage of meter strainers. Suction line from sump pump is connected to it. Gage table is prepared for this, to keep check on all oil that bypasses meters by this route.

ferior quality, which is difficult and costly to pump, builds up until tank cleaning often becomes necessary.

If it is desired to check measure a 50,000-bbl.-per-day stream of crude oil by tank gages, at least two 55,000-bbl. tanks will be required; one for incoming and one for outgoing oil. At $1.25 per barrel of storage space installed, this amounts to 110,000 × $1.25 = $137,500. As shown in Table 4, later in this article, a 50,000-bbl.-per-day crude-oil meter setting will cost about $20,000. So, in a case where meters may be used to reduce or eliminate storage-volume requirements, a big saving in installation costs can be made.

Because of these two advantages and because satisfactory results had been obtained on its own products pipe lines, the company commenced crude-oil-metering experiments for the benefit of its crude-oil pipe-line subsidiaries. Buckeye Pipe Line Co. has cooperated in these tests.

At the outset, it was recognized that meter-proving methods and meter-strainer designs as adopted for pipe-line uses would be entirely impractical with crude oil. Since it was found necessary to develop entirely new proving methods and strainers before p.-d. metering of crude oil could be made practical for pipe-line use, considerable detail pertaining to these two factors is included in this report.

The meters are on a 10,000-bbl.-per-day stream at Mantua, Ohio, where the deliveries from Sohio Pipe Line Co.'s 6-in. line from Stoy, Ill., are received by Buckeye Pipe Line Co. for relay to Cleveland. The crude originated in the Illinois, Kentucky, Mississippi, Louisiana, Arkansas, and Mid-Continent fields. The A.P.I. gravity of most of the oil fell in the 30°-40° range. Line temperatures rarely dropped below 35° F. and hardly ever exceeded 75° F. No sour crudes were handled, but it is not believed that sour crudes would alter installations materially. Of course, sulfuric-acid-resistant metals would be required in certain places and closer attention to ventilation would be called for.

Although the meters were operated experimentally, they were neither controlled nor operated by laboratory methods. Calibrating procedures and operating methods were set up so that metering could be maintained by the regular field personnel. The results as reported herein should be obtainable on any pipe line operated with average care and without more than ordinary supervision by technically trained men when moving crude of similar characteristics.

The schematic diagram in Fig. 1 shows the layout of the Mantua meter setting. It includes a conventional meter and prover tank layout installation, but has some additional features which should be called to the reader's attention (see caption with figures).

Details of the Prover Tank

Fig. 2 shows the essential parts of the prover tank. The tank is mounted on conventional 10,000-lb.-capacity platform scales. The scale beams may be read to 2 lb. and an attachment called a Weight-O-Graph (manufactured by Howe Scale Co.) may be read to within 1 lb. The scale ratio is 1/1,000, i.e., 1 lb. on the beam balances 1,000 lb. on the platform.

Gravimetric or weigh method of proving was selected because of the tendency of waxes, sand, and other solids to deposit out of crude oil. In time, an accumulation of this material would cause a volumetric type of prover tank to become inaccurate.

Where the line from the meters, and the dump line to the sump tank connect to the prover, synthetic-rubber expansion cones are attached. This permits free movement of the scales. The 1-in. spray line is connected with a short length of synthetic-rubber hose.

The line from the meters drops to within 4 in. of the tank bottom, there-

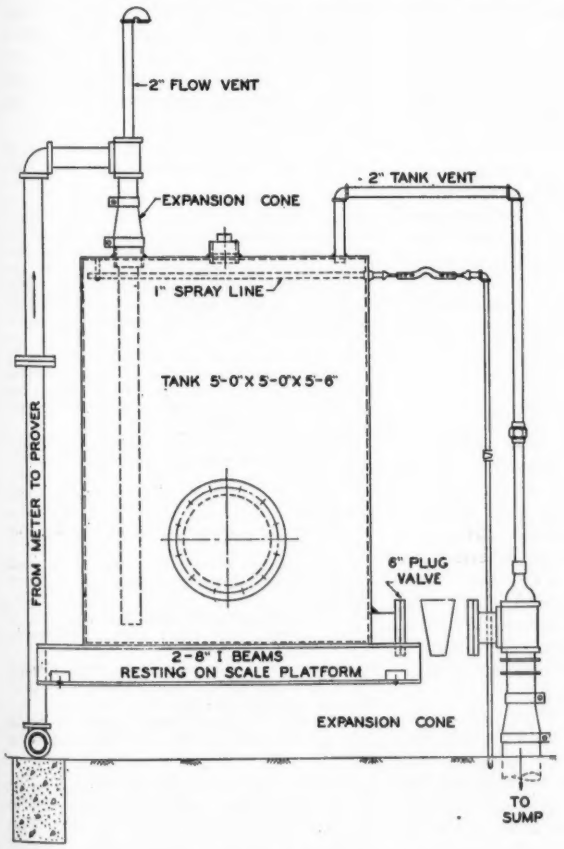


Fig. 2—Gravimetric prover tank

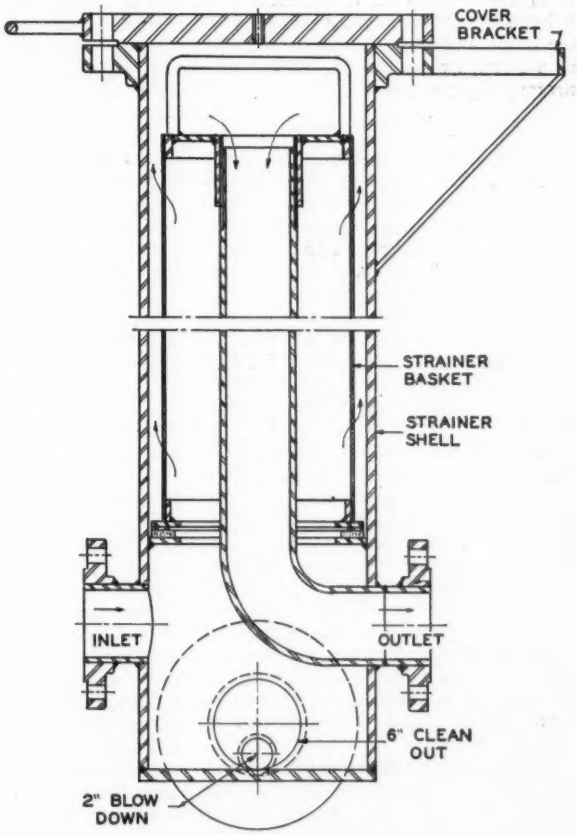
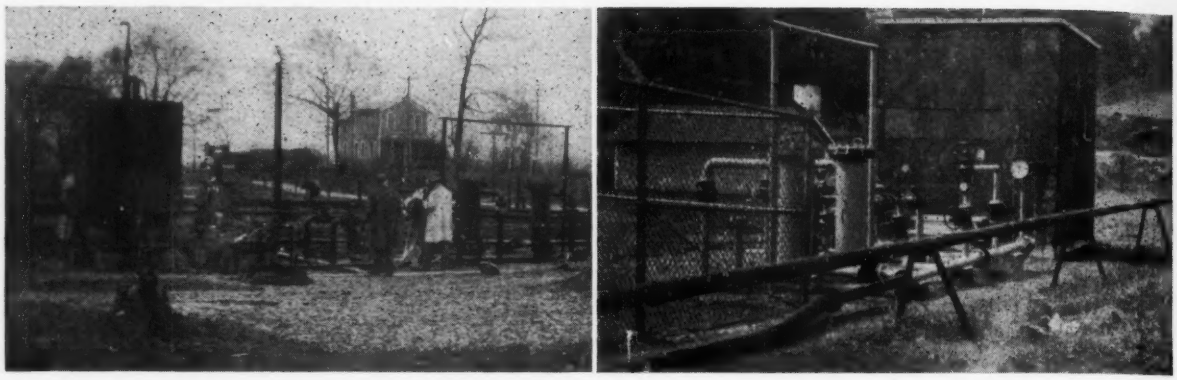


Fig. 3—Crude-oil meter strainer



Two views of the Mantua meter setting. Left: The prover tank is shown resting on its platform scales (photo was taken prior to construction of the wind shelter). Right: View showing the wind shelter which was later erected over the prover tank and scales

by keeping foaming and filling losses to a minimum. Filling losses are further minimized by saturating the tank atmosphere with a spray of crude oil from the 1-in. spray line, and by venting the prover tank dump line to the sump back into the prover tank.

A shelter not shown in the drawing is constructed over the prover tank and scales for wind protection. This was necessary because a slight breeze would otherwise cause the scale beam to move up and down to such an extent that an accurate reading would be virtually impossible. The shelter is a very simple affair. It is constructed of sheet steel and 2 by 4-in. studs, costing about $200 for labor and material. It serves also as a storage place for the meter calibrator's equipment.

Detail of Meter Strainer

Essentials of the strainer are shown in Fig. 3. The strainer basket is inverted so that the incoming stream rises into its open lower end. The crude oil passes through the 10-mesh screen of the basket and then travels upward. Its upward passage is between the outside of the strainer basket and the inside of the strainer shell. The outlet pipe is near the top, in a central position with respect to the outside diameter of the strainer basket.

The strainer shell is designed so that the incoming stream undergoes a sudden change in velocity, traveling very much slower when it enters at the bottom. Slowing the velocity of the crude allows most of the suspended foreign material to settle out before it can reach the 10-mesh screen. As shown in the drawing a large cleanout and blowdown connection is provided at the bottom of the strainer shell. The meter calibrator blows accumulated sediment out at periodic intervals.

The strainer is constructed so that the stream of crude oil, after it has passed through the screen, must travel at a higher velocity than when it is approaching the screen. It is believed that this relationship of screen approaching velocity to screen departing velocity is of importance in the functioning of the strainer. This relationship, plus the central location of the outlet with respect to the periphery of the strainer basket, causes the entire area of the screen to be utilized for cleaning the oil stream.

Many strainers actually utilize only a minor portion of their total screen area and will require changing even though a larger portion of the basket may still be clean. Generally the screen area closest to the outlet completely plugs off while more distant areas remain clear in most conventional strainers.

Only one strainer is used at a time, the other serving as a standby. The strainers are cleaned only about three or four times a year. They are apparently very efficient for we have never had a meter stick as a result of foreign material getting past the strainer. Also the replacement of moving parts in the meters is less frequent than has been experienced on the products pipe lines.

Patent rights covering the strainer design as described above have been applied for and assigned to Standard Oil Co. (Ohio).

Operating Procedures

Although there are two meters in the setting, they are reported one at a time. The meters are alternated, at ½-month intervals, on full stream. The meters are calibrated twice per month, on the first and fifteenth as nearly as possible. The calibrator spends 8 hours at each visit. He proves the meters, lubricates the plug valves, attends to other maintenance matters, and also handles the necessary accounting work.

The meters are conveniently located so that they are read hourly by Buckeye Pipe Line Co. gagers. An hourly meter report is maintained by the Buckeye men, showing meter readings, line temperatures, pressure drops across strainers, and other pertinent data.

Registration of the meters is used to check the barrels delivered according to tank gages. Thus it is not necessary for our representatives to witness opening and closing tank gages. This alone results in sufficient labor and automobile mileage savings to justify the expense of the meter installation.

To insure correct scale readings, an inspection by a scale service man is made regularly every 60 days. The service is provided at a reasonable cost averaging about $15 per trip.

Calibrating Procedure

As a preliminary to calibrating, all valves that are involved in proving the meters are lubricated and tested for leakage. No meter is proved until it has been on stream for at least 1 hour. The procedure is outlined in the following 10 steps:

1. The prover tank is sprayed until it is brought as closely as possible to line temperature.
2. The other meter is placed on the line.
3. A preliminary test run is made, flowing 20 bbl. into the prover tank. The main purposes of this run are to saturate prover-tank and sump-tank atmospheres, wet the inside of the prover tank, and bring prover lines and tank closer to normal operating temperatures. The calibrator may also check the meter rate of flow as indicated by the prover-line flow meter during this run.
4. Preliminary run is dumped to sump tank. Dump valve is closed and about 300 or 400 lb. of oil are retained in prover for opening scale reading.
5. Meter discharge valve to line is closed. Opening meter reading and opening scale reading are noted.
6. Meter discharge valve to prover tank is opened. Rate is adjusted by setting valve according to indicating flow meter on prover line.
7. Composite sample stream is opened into sample can immediately after starting flow to prover.
8. Approximately 20 bbl. are run to the prover tank and then meter discharge valve is closed.
9. Closing meter reading and closing scale reading are noted. Meter is then switched back to line.
10. Tank is sprayed while prover is being dumped, preparing it for the following test run.

The second as well as all immediately following test runs are made as outlined in steps 5 to 10. The calibrator makes the preliminary and four test runs, one immediately after

the other without stopping to calculate meter factors. One composite sample of the four test runs is used for determining the specific gravity of the oil.

Determining Gravity of Crude Oil

The calculation of a meter factor is made by converting meter barrels into pounds and comparing with the scales. In order to change the volume into weight it is of course necessary to know the density or gravity of the oil.

Certified hydrometers, with A.P.I. gravity calibrations were tried at first. Standard Westphal balance which gives specific gravity readings has since been adopted. It is easier for the calibrator to read, particularly on very dark and heavy crudes. It also gives more accurate results. A special table showing pounds per barrel at the specific gravity read is furnished to the calibrator to facilitate his work. A section of the table is shown in Table 1. Note how much closer the density may be figured when specific gravity rather than A.P.I. gravity is used.

TABLE 1—SECTION OF SPECIFIC GRAVITY TO POUNDS PER BARREL CONVERSION TABLE

A.P.I. gravity	Specific gravity	Lb. per barrel
37.5	0.8463	295.97
	0.8462	295.93
	0.8461	295.89
	0.8460	295.84
	0.8459	295.80
35.8	0.8458	295.76
	0.8457	295.73
	0.8456	295.70

In case the meters have temperature compensators which automatically correct the registered volume to a 60° F. basis, the observed specific gravity is corrected to 60° F. This correction may be read directly from a handbook. Circular C410, National Bureau of Standards, U. S. Department of Commerce, entitled National Standard Petroleum Oil Tables.

For meters without temperature compensators, the procedure is somewhat more complicated. For example, take a specific case of a meter being proved with the line temperature at 48° F. This is of course the meter registration temperature also, since the line temperature is taken at a point immediately adjacent to the meters. Therefore, the specific gravity of the crude oil must be determined on a 48° F. basis instead of on a 60° F. Let us assume that, using the Westphal balance, a specific gravity of 0.8483 at 41° F. was observed. The correction to a 48° F. basis is made in the following manner:

1. On page 112, National Standard Petroleum Oil Tables, find the gravity corrected to 60° F.

0.8483 at 41° F. = 0.8413 at 60° F.

2. The specific gravity changed by 0.0070 in 19° F. 0.8483 — 0.8413 = 0.0070 difference. 60° — 41° = 19° change.

The specific gravity change per degree $= \frac{0.0070}{19^\circ} = 0.000368$ per degree.

3. In the 7° difference between 48° F. and 41° F. the specific gravity will change:

$7 \times 0.000368 = 0.0026$ total change.

4. As oil gets warmer, its density decreases. Therefore the 0.0026 correction should be deducted to correct from 41° F. to 48° F. Had the correction been from 48° F. to 41° F., it would have been added since oil density increases as the oil grows colder.

5. Observed specific gravity 0.8483 at 41° F.
Subtract 0.0026

Corrected specific gravity 0.8457 at 48° F.

6. Check:
(a) See if 0.8483 at 41° F. corrected to 60° F. is the same as 0.8457 at 48° F. corrected to 60° F.
(b) 0.8483 at 41° F. = 0.8413 at 60° F.
0.8457 at 48° F. = 0.8412 at 60° F.

0.0001

(c) The check should be within 0.0001 if calculations are correct.

The above steps are extracted from instructions to calibrators at Mantua. Our regular field men have no difficulty in using this step by step procedure.

Calculation of Meter Factors

As an aid to the calibrator a meter test form is supplied. It outlines the necessary steps for calculating a meter factor. A part of this form is shown in Table 2. The complete form is 8½ by 11 in. and provides space for each of the four test runs and some other test data as well.

The results of a calibrating test run are shown in the meter-test report in order to demonstrate its use. This is taken from the calibration of a meter without a temperature compensator. The line temperature was 48° F.

Item 1—Closing meter reading minus opening reading was 20.002 bbl. The observed specific gravity (0.8483 at 41° F.) was determined from a composite sample of the four test runs.

Item 2—Calibrator consults the conversion table (see Fig. 4) and determines that a barrel of oil with a specific gravity of 0.8457 weighs 295.73 lb. 20.002 × 295.73 = 5,915.19 lb.

Item 3—Scale closing minus scale opening reading.

Item 4—In so far as the calibrator is concerned this item is self-explanatory. The correction is discussed later in this article.

Item 5—Self-explanatory.

TABLE 2—METER TEST REPORT

Mantua, Ohio — Date .....
Meter No. A — Serial No. ..... — Make .....
Product metered—Illinois Basin. — A.P.I. gravity 36.7 at 60° F.
Item—First test — Line temperature—48° F.

(1)	Barrels by meter 20.002 bbl. at 48° F.	0.8483 specific gravity at 41° F.
(2)	Weight by meter 5,915.19 lb.	0.8457 specific gravity at 48° F.
(3)	Weight by scales 5,879 lb.	Rate of flow 500 b.p.h.
(4)	Buoyancy correction (0.38 × Item 1)	7.60 lb.
(5)	Corrected scales (Item 3 + Item 4)	5,866.60 lb.

Factor = $\frac{\text{Item 5}}{\text{Item 2}} = 0.9952$

The final determination of the factor is also self-explanatory. Each of the four test runs is figured in the above steps. From the four factors thus obtained the average factor is selected.

Computation of Average Factors

The average factor is used to correct the meter registration. In the case of meters without temperature compensators line temperature is averaged and a temperature factor is also applied. The average factor is computed as follows:

1. All consecutive runs within 0.0005 of one another are averaged. Here are some examples:

	1	2	3
Run 1	0.9995	0.9995	0.9980
Run 2	0.9993	0.9991	0.9993
Run 3	0.9998	0.9980	0.9994
Run 4	0.9994	0.9991	0.9990
Average factor	0.9995	0.9993	0.9994

All four runs are within 0.0005 so all are used.

Consecutive runs (Column 2) Nos. 1 and 2 are used.

Consecutive runs (Column 3) Nos. 2, 3, and 4 are used.

2. If no consecutive runs are within 0.0005 of each other, all four runs are averaged. For example:

Run 1	0.9995
Run 2	1.0002
Run 3	0.9994
Run 4	1.0000
Average factor	0.9998

This is somewhat stricter than the procedure recommended in the A.P.I. positive-displacement meter code. The code requires a preliminary run and subsequent test runs until two consecutive runs are within 0.0005 of each other, but also specifies a four-run limitation. The four runs are averaged as above if no two consecutive tests are within the 0.0005 range. There may be a tendency to juggle readings in order to help test runs Nos. 1 and 2 fall within the 0.0005 range. This tendency may be more pronounced on very cold and dark winter mornings. This is written from personal experience.

Explanation of Buoyancy Correction

In Item 4 of Table 2 there appears a correction of 0.38 lb. per barrel. The reasons for this correction should be discussed in some detail.

The Westphal balance (and A.P.I. hydrometers as well) compares the weight of oil and the weight of water as though they were balanced in a

TABLE 3—QUARTERLY THROUGHPUTS BY METERS AND BY TANKS AT MANTUA, OHIO—1945, 1946, AND 1947
(Meter setting put into operation March 20, 1945)

	Meters (bbl.)	Tanks (bbl.)	Difference (bbl.)	Difference (per cent)
1945—				
First quarter	118,626.00	116,633.00	+1,993.00	+1.71
Second quarter	947,519.99	947,784.73	—264.74	—0.03
Third quarter	925,099.95	927,615.72	—2,515.77	—0.27
Fourth quarter	641,521.40	641,473.94	+47.46	+0.01
Total	2,632,767.34	2,633,507.39	—740.05	—0.02
1946—				
First quarter	942,189.99	943,691.38	—1,501.39	—0.16
Second quarter	981,065.55	982,330.04	—1,264.49	—0.13
Third quarter	1,035,082.17	1,035,258.29	—1,761.12	—0.17
Fourth quarter	973,542.06	972,359.32	+1,182.74	+0.12
Total	3,931,879.77	3,933,639.03	—1,759.26	—0.04
1947—				
First quarter	863,525.65	862,878.55	+647.10	+0.07
Second quarter	933,944.68	934,209.50	—264.82	—0.03
Third quarter	1,049,847.93	1,046,332.24	+3,515.69	+0.34
Fourth quarter	941,544.70	941,118.42	+426.28	+0.05
Total	3,788,862.96	3,784,538.71	+4,324.25	+0.11
1945	2,632,767.34	2,633,507.39	—740.05	—0.02
1946	3,931,879.77	3,933,639.03	—1,759.26	—0.04
1947	3,788,862.96	3,784,538.71	+4,324.25	+0.11
Total	10,353,510.07	10,351,685.13	+1,824.94	+0.02

TABLE 4—COST ESTIMATE FOR CRUDE-OIL METER SETTINGS

Throughput capacity, b.p.d.	10,000 (418 b.p.h.)	20,000 (836 b.p.h.)	30,000 (1,250 b.p.h.)	40,000 (1,670 b.p.h.)	50,000 (2,080 b.p.h.)
Meters required	Two 4-in.	Two 6-in.	Three 6-in.	Three 6-in.	Four 6-in.
Total cost installed	$10,000	$12,000	$15,000	$17,000	$20,000

Note: Costs shown are for low-pressure settings. All valves, fittings, etc., are figured as 150-lb. steel A.S.A.

vacuum. This is called the "true weight."

Assume a set of equal arm balances in water. On one side there is a barrel of crude oil (volume of 1 bbl. = 5.615 cu. ft.); on the other side there is a cast-iron weight. The true weight of the oil is 359 lb. The true weight of the cast iron is 10 lb. But in the water they balance exactly. So that the apparent weight of a barrel of oil weighed under water is only 10 lb.

The oil occupies a space of 5.615 cu. ft. In displacing water which weighs 62.4 lb. per cu. ft., it is buoyed up by $5.615 \times 62.4 = 350.37$ lb. The cast iron weighs 450 lb. per cu. ft. and it therefore occupies a space of $10/450 = 0.022$ cu. ft. It is buoyed up in water by $0.022 \times 62.4 = 1.37$ lb.

In order to determine the true weight of the oil as though it were weighed in a vacuum, we apply a water-buoyancy correction:

$$5.615 \times 62.4 - 0.022 = 62.4$$

$$= 350.37 - 1.37 = 349 \text{ lb.}$$

Add this to the apparent weight $349 + 10 = 359$ lb., true weight of the oil.

To a lesser degree the same factors are encountered when weighing in air as when weighing in water. However, since the weight of a cubic foot of air changes with temperature, moisture content, and elevation, we should theoretically determine air pressure, relative humidity, and temperature of air and then compute its weight per cubic foot at each calibration. This would require such extensive equipment and calculations that it would certainly render weight proving of meters burdensome, if not utterly impractical for nontechnical men.

By assuming a constant air weight of 0.075 lb. per cu. ft. at Mantua, we have eliminated this procedure. The resulting error is never more than 0.01 lb. per cu. ft. Cold, dry air (at Mantua) would weigh 0.085 lb. per cu. ft. Moist warm air would weigh 0.065 lb. per cu. ft. This maximum 0.01 lb. error would amount to 2 bbl. on a 10,000-bbl. delivery, or 0.02 per cent. Normally we are not out more than ½ bbl. in 10,000 or 0.005 per cent. Moreover throughout the period of a year these errors compensate and tend to cancel out entirely.

Using the assumed air density of 0.075 lb. per cu. ft. (this would, of course, vary according to the elevation of the meter setting) the buoyancy correction is calculated.

$$\text{B.C.} = d\left(V_o + V_s - \frac{V_b}{\text{S.R.}}\right)$$

B.C. = buoyancy correction
d = air density 0.075 lb. per cu. ft. in this case
V_s = volume of steel in prover tank, its piping and fittings, I-beams, etc., on scale platform
V_o = volume of oil run to prover per test run. $20 \times 5.615 = 112.3$ cu. ft. in this case
V_b = volume of brass in scale weights for balancing the weight of $V_o + V_s = 0.016$ cu. ft. in this case
S.R. = scale ratio = 0.001 in this case

Note: The following densities were used in computing the above volumes: Steel = 490 lb. per cu. ft.; brass = 525 lb. per cu. ft.; oil = 300 lb. per bbl.

$$\text{B.C.} = 0.075\left(112.3 + 5.3 - \frac{0.016}{0.001}\right)$$

B.C. = 7.62 lb. total correction of 20 bbl.

$$= \frac{7.62}{20} = 0.38 \text{ lb. per barrel.}$$

Each meter setting will have its own constant buoyancy correction. It will, of course, vary with elevation, type of scales, barrels run to prover tank, etc. Such a constant will be well within the commercial limits of accuracy. If the buoyancy correction is neglected, the error will amount to about 0.1 per cent. Using the constant for buoyancy correction with the meters at Mantua they have checked within 0.02 per cent of the tank gages for the 10,350,000 bbl. which they have measured during the past 2¾ years.

Accuracy Achieved With Gravimetric Proving

Table 3 compares the quarterly throughputs as metered with the barrels as shown by tank measurements for 1945, 1946, and 1947.

Table 4 shows the estimated costs of meter settings at varying capacities with recommended meter combinations.

Conclusion

No figures on maintenance costs were shown in this report. Different makes of meters were purchased and tried out at Mantua and their maintenance costs were widely varying. One make of meter has registered 4,100,000 bbl. without requiring a penny's worth of repair of any kind, and it is still apparently in good condition. Other makes tried have not had quite such good parts-replacement records, although all of them have given better results than had been experienced with refined-products meters.

Based on the Mantua tests, it is the personal opinion of the writer that meters without temperature compensators are somewhat more accurate and reliable than meters equipped with them. It seems that a temperature compensator (as developed at present) is an added expense, both in first cost and maintenance, that adds nothing to the reliability or accuracy of crude-oil measurement.

Several different men were employed as calibrators in order to insure that we had not set up a one-man operation. Any alert, conscientious pipe-line man will become adept at gravimetric-meter proving after about 2 weeks of training. Calibrators who have had previous experience with volumetric provers on products pipe lines prefer gravimetric system.

The experience with the meters at Mantua has proved that crude-oil metering may (for most grades of crude oil) be substituted for tank crude-oil without any loss of accuracy in measurement.

DIGESTS

NATIONAL ASSOCIATION CORROSION ENGINEERS

The papers here digested were presented at the N. A. C. E. conference held in St. Louis, April 5-8, inclusive

Effects of Hydrogen Generated By Corrosion of Steel

M. H. BARTZ and C. E. RAWLINS, Phillips Petroleum Co., Bartlesville, Okla.

WHEN steel equipment is corroded by the hydrogen sulfide in sour crudes, gases, and gasolines, additional damage, more serious than that resulting from loss of metal, frequently is encountered. That damage manifests itself as embrittlement of high-strength steels and blistering of lower-strength steels. It results from hydrogen that is liberated during corrosion diffusing into the steel.

Pressures up to 2,700 psi. have been encountered in gases entrapped in blisters. Chemical analysis showed this gas to be nearly pure hydrogen. A destruction test of a service-blistered vessel showed that the blisters had reduced the load-carrying capacity of the metal by about 20 per cent. Consideration is given to the causes and possible methods of preventing embrittlement and blistering of steels used in the petroleum industry.

Action of Rust-Preventive Oils

E. R. BARNUM, R. G. LARSEN, and A. WACHTER, Shell Development Co., Emeryville, Calif.

THE rust-preventing efficacy of oil films on steel can be enhanced greatly by addition of certain organic compounds to the oil. The mechanism by which these additives function is discussed on the basis of results from experimental studies of the nature and degree of surface adsorption, the behavior of different types of molecular structure, the fundamental principles of water-displacement action, and the behavior of additives applied by different methods to steel surfaces. Laboratory tests for evaluation of rust-preventive oils are described.

Sour Crudes—Equipment Protection

E. Q. CAMP, Humble Oil & Refining Co., Baytown, Texas.

THIS paper discusses some of the major corrosion problems in refining sour crudes. Experiences in the use of various alloys, coating materials, and special procedures for increasing life of equipment in storage, transportation, and distillation of sour crudes and distillates are reviewed. Consideration is given to protective measures against corrosion at high temperatures in cracking service. The role of sulfur as an inhibitor for two types of corrosion is discussed.

Corrosion Problems in a Modern Fluid Catalytic Cracking and Fractionating Unit

NATHAN SCHOFER, Cities Service Refining Corp., Lake Charles, La.

CORROSION problems in a modern fluid catalytic cracking unit, containing very little alloy steel, and its fractionation unit are discussed. Corrosion in the cracking unit is very low, largely because the hot vessels and lines are coated with carbon freed in the cracking process.

Low-temperature attack is prevented by the ammonia formed in the process. The fractionation system, which previously had only cooling-water corrosion problems, became quite troublesome when the refinery began processing a small amount of high-sulfur crude oil. Carbon-steel furnace and exchanger tubes failed in only a few months. Steel in several process vessels blistered and cracked. It is believed hydrogen penetration was responsible.

Cathodic Protection Applied To Gas and Electric Utility Operations

WILLIAM J. SCHREINER, Cincinnati Gas & Electric Co., Cincinnati.

CATHODIC protection has been applied to various parts of the underground plant of a gas and electric utility system in a metropolitan area. Applications include protection of power cable sheaths, gas transmission lines, and distribution mains. Sources of potential for the productive currents are rectifiers, magnesium anodes, and aluminum anodes. Preliminary investigations to indicate the need for protection were made by means of potential surveys, corrosivity surveys using the Columbia rod, and resistivity surveys using the ground megger. Adequacy of the protection applied is measured by taking periodic current and voltage readings.

Laboratory Determination of the Relative Corrosion Resistance of Metals Considered for Condensate Well Service

C. K. EILERTS, FAYE GREENE, F. G. ARCHER, and L. M. BURMAN, U. S. Bureau of Mines, Bartlesville, Okla.

THE Bureau of Mines in cooperation with the corrosion research project committee of the N.G.A.A. and the condensate-well corrosion committee of N.A.C.E. has made laboratory tests of the relative rates of corrosion of metals considered for use in the manufacture of well equipment.

The corrosion resistance of 34 metals was measured propionic and carbonic acid test mediums under conditions simulating the service conditions that prevail in the flow stream of wells subject to corrosion. The list of metals includes 4 carbon steels, 7 chromium steels, 4 nickel steels, 3 chromium-nickel steels, 2 copper steels, 11 copper and aluminum alloys and 3 plated steels.

The carbon steel commonly used in the manufacture of J-55 tubing was one of the metals most susceptible to corrosion. The case steel containing 12.48 per cent of chromium and 4.47 per cent of nickel was the metal least affected by corrosion and yet possessing the physical properties required for service at high pressure.

Other metals which will meet requirements for mechanical strength of J-55 tubing and which have corrosion resistance significantly better than the corrosion resistance of J-55 tubing are as follows: Croloy 9, Croloy 12, and the metal containing 9 per cent nickel.

Brine Corrosion in the Oil Industry

H. T. KENNEDY, Gulf Research & Development Co., Harmarville, Pa.

SERIOUS corrosion by brine in the oil industry is mainly limited to three classes. These are: (a) corrosion by acid waters, which may be fresh or salty, in wells producing fluids of the condensate type; (b) corrosion by brines containing large quantities of hydrogen sulfide; and (c) corrosion by brines which contain oxygen. Current information on the causes and remedies for each type of corrosion is reviewed, along with experimental work which is now in progress.

Preparation of Metal Surfaces For Organic Coating

G. R. HOOVER, American Rolling Mill Co., Middletown, Ohio.

DURABILITY of organic coatings applied over metal surfaces depends to a great extent on the preparation of the surface prior to application of the organic coating. Methods of cleaning will depend upon the nature of the material to be removed from the metal and the character of the metal.

Chemical treatment, to convert the surfaces of easily corrodable metals and metals that are known to react chemically with organic coatings to a more stable and nonreactive surface, will greatly increase the useful life of the organic coatings. Most coating failures develop at the metal coating interface and any recommended coating system should not only take into consideration the suitability of the coating for a given service, but should also specify the treatment of the metal prior to coating.

Fifteen Years' Experience in Application of External-Corrosion Mitigation Methods to a High-Pressure Natural-Gas Transmission Line

N. K. SENATOROFF, Southern Counties Gas Co., Los Angeles.

COATING specifications of several classes of coatings used for external protection of the line from corrosion, complying with the prevailing practices of 1932 to select and specify coatings with respect to the varying soil characteristics are described in this paper. It also states coating performances during the last 15 years, and evaluates the cost of a typical cathodic-protection station installation together with the maintenance and operating costs of pipe protection. In conclusion, the author discusses the changes in pipe-protection practices in the light of present-day requirements.

Present-Day Aspects of Condensate Well Corrosion

HARRY E. WALDRIP, Gulf Oil Corp., Houston.

THIS paper briefly describes what condensate well corrosion is, characteristics that classify these types of wells, methods of detecting the extent of the corrosion, and the costs of the resulting corrosion. It also deals with the method in which the problem is attacked. This includes a

discussion of coating materials, chemical or inhibition treatment, and alloy tubing. A brief future picture of the problem is given.

Principles of Protecting Metals With Organic Coatings

ARNOLD J. EICKHOFF and WILLIAM E. SHAW, Research Laboratories, National Lead Co., Brooklyn.

TWO aspects of paint protection are described. One aspect concerns fundamentals of protection mechanisms, adhesion, and blistering. The various theoretical mechanisms of protection are reviewed in historical sequence with emphasis on the current electrochemical theory and the free-energy concept.

Adhesion is considered as the resultant of two main types of phenomena—mechanical and electrical. The factors responsible for blistering and adhesion of paint coatings to steel are discussed. The second aspect is concerned with practical considerations and includes a discussion of exposure environment and the application and functions of metal primers and top coats. Brief mention is also made of the importance of surface condition and its effect on subsequent adhesion.

Reference Electrodes: Design and Polarization Characteristics

RAYMOND F. HADLEY, F. A. YOUNG and D. F. VAN DE WATER, Susquehana Pipe Line Co., Philadelphia.

POLARIZATION data relating to the copper-copper sulfate, cadmium-cadmium sulfate, lead-lead chloride, silver-silver chloride, saturated calomel, and silicon carbide reference electrodes are reported from null-method measurements. The effect of age upon certain electrodes has also been studied and the data included.

Null method data for various electrode metals subjected to a uniform current density, and electrodes subjected to a variation in current density due to the geometrical shape of the electrode have also been studied and reported. A number of the more important factors relating to the design of reference electrodes for field use are indicated. The design of calomel electrodes suitable for field use is also reported. This paper can, in general scope, be considered supplemental to Scott Ewing's American Gas Association publication, "The Copper-Copper Sulfate Half-Cell for Measuring Potentials in the Earth. The Cadmium-Cadmium Sulfate Half-Cell for Measuring Potentials in the Earth."

Analysis of Nace Condensate Well Corrosion Field Data

V. V. KENDALL, National Tube Co., Pittsburgh.

AN analysis and correlation of results of the N.A.C.E. Condensate Well Committee's investigation into the corrosion resistivity of various metals. The 32 steels and alloys examined were placed on spools, using four coupons for each of seven wells tested under widely varying corrosive conditions in the field for a 90-day period.

Conclusions, based on loss of weight and pitting effects, are: (1) Stainless steels of the 18-8 class, were entirely resistant; (2) 9 per cent chromium or 9 per cent nickel were satisfactory for severe condensate-well conditions; (3) nickel-plated steel of the quality tested was satisfactory; (4) 5 per cent chromium and 5 per cent nickel were resistant in moderately corrosive wells; (5) copper-base alloys were effective for most conditions; (6) galvanic effects were negligible. Complete tabulation of data and calculated results with related curves are included.

Cathodic Protection of Casings In Loudon Pool

S. P. EWING and J. F. BAYHI, Carter Oil Co., Tulsa.

THE first casing leak in Loudon pool occurred in 1944, about 7 years after its discovery. The leak rate increased until 1946, when use of electrical insulation between flow lines and casings greatly reduced the rate.

Measurements described in this report were made to determine whether cathodic protection would further reduce the leaks. Well casings were found to be essentially alike so that measurements on only a few casings were necessary.

Current required to protect casings were made by two methods: (1) by I.R. drop measurements along the casings and (2) by current-potential curves of the external surface of the casing. Protection of a 1,500-ft. casing by 1.50 amp. of current was indicated.

BOOKS

WORLD MARKETS DIRECTORY. Published by Atlas Publishing Co., 425 West 25th Street, New York. 1,290 pp. $15.

The 1948 edition of this volume contains more than 60,000 firms, located in every important country of the world, that either manufacture commodities or that do an import and export business. The book is divided into three sections: (1) Commodity Index, (2) Commodity Listings Section, and (3) Geographical Section. A special section is devoted to Germany and Japan in which appears the names of the officials of the Armies of Occupation who have the control and direction of all imports and exports of these countries.

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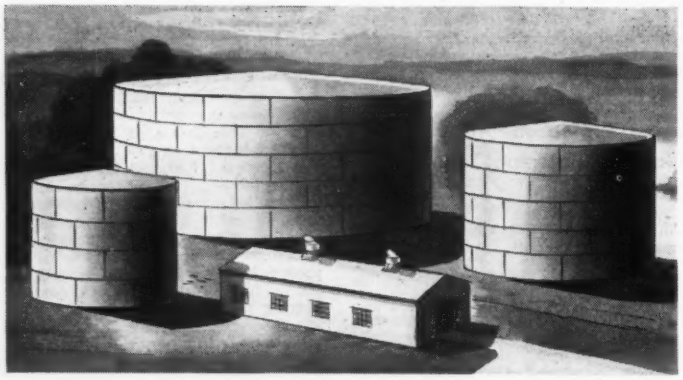

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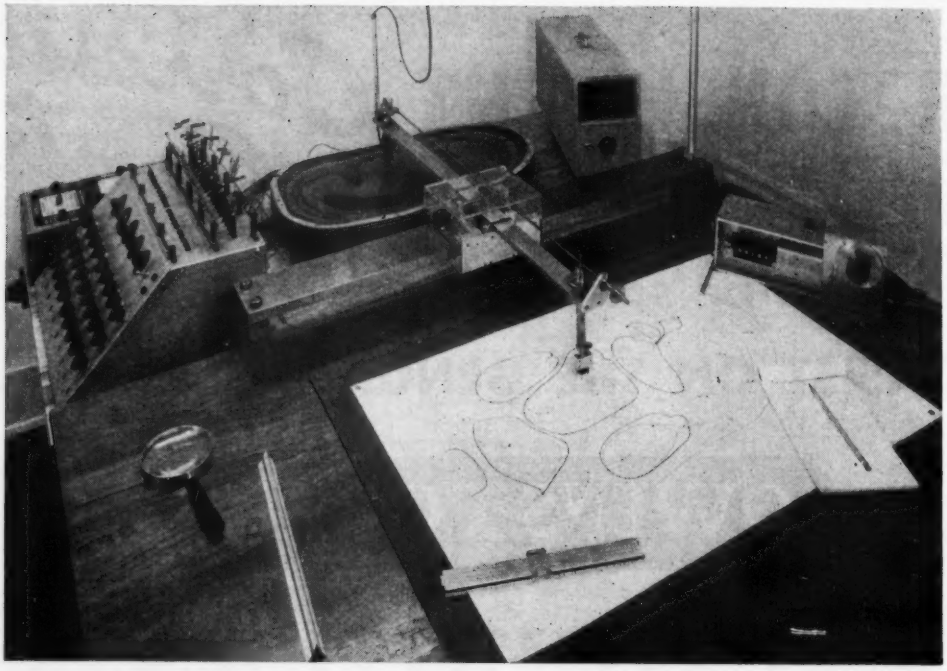

Fig. 1—One type of potentiometric apparatus. The conducting pool, shaped to conform to the isopach map of the reservoir, can be seen in the center background. Mechanism in the figure enables operator to work directly on a map of the reservoir (center front)

Use of *Electrical Models* in Study of *Secondary Recovery Projects*

by Alexander Wolf, Ph.D.*

SECONDARY recovery has been defined as any method of oil or gas-field exploitation in which the produced fluid is displaced by some other fluid artificially injected into the reservoir. Under this definition the term embraces such widely different operations as artificial waterflooding, gas-cap repressuring, gas cycling, and perhaps some others. The first of these, water flooding, is really "secondary" in the sense that in the past it has been used only after a reservoir had previously been depleted by the so-called "primary" recovery methods. On the other hand gas-cap repressuring is frequently applied during the earlier stages in the life of a field, whereas gas cycling, far from being "secondary," is the very first step in the exploitation of a gas-condensate reservoir.

From the point of view of the writer, or anyone else engaged in electrical model studies, the grouping of these various projects under the single heading of secondary recovery is most felicitous. These various projects have this aspect in common that once a decision is made to inject water or gas into a reservoir there arises the question as to how the injected fluid will spread through the field, how soon and in what sequence it will break into the producing wells, what fraction of the reservoir can be flooded with a given number and arrangement of wells, and what improvement in the flood pattern can be secured by a different well arrangement. These questions can be answered only by mapping the expected progress of the interface between the injected and the displaced fluids, as this interface proceeds from the injection to the producing wells.

The mapping of the interface between the two fluids is accomplished by means of an electrical analog of the oil or gas reservoir, which consists of some form of electrical conductor shaped like the field, in which the oil, water, or gas flows are simulated by electric currents. Strangely enough this turns out to be more practical than a mechanical model, which might consist of some porous material through which two fluids would be pumped. Apart from the technical difficulties with the mechanical model, its chief disadvantage would be in the fact that in a small model flow would be controlled in a large measure by surface tension. These are quite large on the reduced scale of the model, but are quite unimportant in the full-size operation.

History of the Model

Secondary recovery is not new. Professor Uren states' that the first artificial gas-oil drive was instituted in 1911. For many years thereafter petroleum engineers were so preoccu-

*Consulting physicist, Houston.

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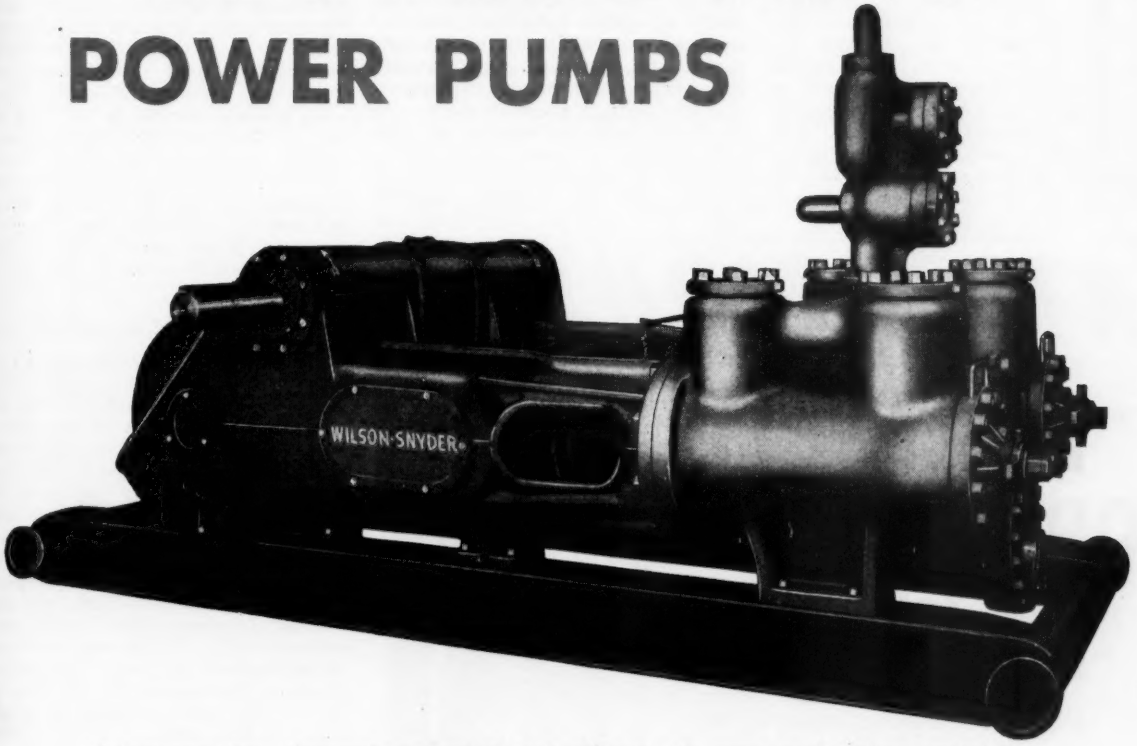

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No. 36-P	3x6	3	2	1420	140	75	77
No. 46-P	4 1/2x6	4	3	630	140	75	175
No. 6P-HD	4x6	4	3	410	100	36	126
No. 6P-LD	5x6	6	3	260	100	36	200
No. 8P-HD	5x8	6	3	600	80	85	205
No. 8P-LD	7 1/4x8	8	6	275	80	85	445
No. 12-P	5x12	6	4	540	70	100	270
No. 12P-LD	6x12	6	4	365	70	100	395
No. 612-P	6x12	6	4	520	70	140	390
No. 612P-LD	7 3/4x12	10	6	305	70	140	665
No. 712-P	7 1/4x12	8	4	550	70	220	580
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pied with every-day operating problems, and so overwhelmed with the complexity of the issues, that they only vaguely concerned themselves with the manner in which the injected fluid proceeds toward the producing wells. It was not until the early 1930's that Wyckoff, Botset, and Muskat[2,3] of Gulf Research & Development Co. clearly pointed out that the movement of the interface between the two fluids is governed entirely by Darcy's law, and how, in the simpler cases, the problem can be solved mathematically. They also showed how problems of more complicated geometry could be solved by the analogy with electrical currents in a conductor similar in shape to the reservoir. They carried out the electrical-model experiments for the simpler cases and demonstrated the excellent agreement btween the model results and the calculation.

As far as can be determined from the published literature the application of the electrical model to the study of entire reservoirs was not accepted too readily. It was not until the advent of cycling, with its huge expenditures for plant construction, that the method gained wide acceptance, but only for cycling projects. The method is not yet generally employed in the study of water flooding or gas-oil drives, perhaps because of the prevalence of an erroneous impression that the method is not applicable to two fluids which differ in viscosity, density, or relative permeability.

The electrical model is nothing but an electrical conductor similar in shape to the oil or gas reservoir, but of course on a vastly reduced scale. The reduction is much greater horizontally than vertically. The model is usually a pool of water rendered conducting by the addition of a copper salt. Electric current is led into and out of the model by means of electrodes introduced at points corresponding to the location of the injection and production wells. By means of external rheostats these currents are made proportional to the injection and production rates of the various wells.

Principle of the Model

In view of the formal analogy between Darcy's law and Ohm's law, and the similar geometry of the two systems, the direction of the current at any point of the model is the same as the direction of fluid flow at the corresponding point in the field. There exists also a fixed ratio between the electrical potential (voltage) gradient in the model and the pressure gradient at the corresponding point in the field. Since the flow velocity is proportional to the pressure gradient, it follows that from measurements on the potential gradients in the electrical model one can predict the velocity of flow at any point in the field.

In case only semiquantitative results are desired even these simple measurements can be dispensed with. A direct-current gelatinous model, developed by Wyckoff and Botset[2], and later improved by Swearingen[4], enables one to see or photograph the spreading of the injected fluid by means of colored ions introduced into the model at the electrodes corresponding to the injected wells.

The Potentiometric Model

More precise results, particularly in regard to reservoir performance after first breakthrough of the injected fluid into the producing wells, are obtained with the so-called "potentiometric" model. In this case the model consists of a pool of conducting liquid, rather than a gelatinous mass. Alternating current is employed in order to avoid polarization. Measurements are made on the voltage distribution in the liquid by means of one or more movable probes which are connected to a voltage-measuring device. It is this measurement of electrical potential which gives the method the name potentiometric.

As first constructed in the laboratories of Gulf Oil Corp. and the Humble Oil & Refining Co., the potentiometric model employed only one probe and rather rudimentary instrumentation. A lengthy and tire-

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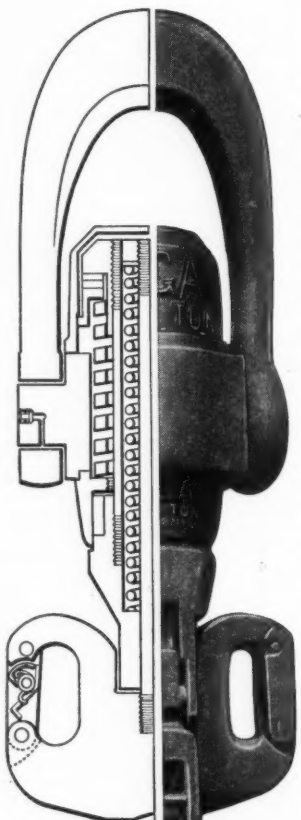

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some process of graphical work and computation was required as a transition from the model to the final result[5]. The potentiometric work consequently was not used very widely. It was only with the introduction of a multielectrode probe system by the writer and B. D. Lee[6], and considerable refinement in the instrumentation, that the potentiometric model surpassed the earlier gel model in speed on certain classes of problems, and closely approached it on others. From the point of view of accuracy the potentiometric model is of course far superior to the earlier gel model, particularly where it is desired to study the later phases of an operation. The potentiometric model is also capable of taking care of a much greater range of problems. Since, in contradistinction to the gel model, the conducting pool is not altered by the operation, the work with the model can be stopped at any time and resumed at will, steps can be retraced, conditions altered, etc.

With the apparatus which has been developed the operator traces flow lines in the model without any intermediate steps, and simultaneously measures the time required by the injected fluid to reach successive positions along each flow line. He thus establishes the flow pattern and a timetable for the flow. A smooth line connecting points of equal time is, of course, the boundary between the two fluids at the time in question.

Fig. 1 is a photograph of one type of potentiometric apparatus. The conducting pool, shaped to conform to the isopach map of the reservoir, can be seen in the center background. The mechanism in the center of the figure enables the operator to work directly on a map of the reservoir (center front). The back end of the bar carries the probes which dip into the conducting pool. The current controls for the electrodes which represent the wells can be seen at the left. The device on the right measures the transit time of the invading fluid over short segments of the path and keeps a tally of the total time elapsed from any arbitrary point along the path.

Application to Gas Cycling

As mentioned before, the potentiometric model has been used mainly in the study of cycling operations. This is true in part because of economic factors, in part because in gas cycling one has the simplest case of the displacement of one fluid by another. As is well known, the dry and the wet gases do not differ much in viscosity, density, or relative permeability.

As regards the economic aspect, the large investment required for the construction of the usual cycling plant makes it imperative that continuity of operation at or near plant capacity be maintained as long as possible. Where only one reservoir exists the operation of the plant at a fraction of capacity would result, unless one insures that dry gas reaches most of the producing wells almost simultaneously, thus putting an abrupt stop to the entire operation. Where more than one reservoir exists in the field, the eventual decline of production from one reservoir must be anticipated in order that wells may be completed in the next reservoir in time to supply the deficient production from the first. Again, gas-condensate reservoirs are usually quite deep; not many wells are available or necessary for their exploitation. However, with only a few wells one may easily trap great quantities of wet gas behind pockets of dry gas, unless the dry-gas invasion pattern is carefully controlled.

One must bear in mind the fact that the electrical model is capable only of predicting the shape and position of the areas flooded by dry gas, and also the approximate dry-gas dilution which may be expected after breakthrough. It gives this information for one set of conditions, that is well arrangement and flow rates. To find the best well arrangement and flow rates one must try various combinations. As in most design problems the best solution is found only after many trials. Thus a great deal depends on the experience and ingenuity of the person conducting the study.

The first thing which is required to conduct a model study is a map of the reservoir contoured in terms of gas volume per unit surface area. This is simply the isopach map, corrected for variations in porosity and connate water, provided sufficient core analyses are available. The map should, of course, show the location of all existing and proposed wells, and the producing or injection capacity of each. In case the reservoir is faulted, the position and magnitude of throw should be shown on the map.

In case two or more reservoirs are operated in parallel, an estimate must be made as to the distribution of production and injection between the reservoirs for each well. This distribution is based on the number of millidarcy-feet exposed in each well. If any dry gas had been injected prior to the model study, the injection and production records of all the wells must be furnished so that one may determine what areas are flooded at the beginning of the study.

A most important factor, which is usually neglected in model studies, is the horizontal variation of permeability over the reservoir. The neglect of this factor may lead to very serious discrepancies between the predictions and the subsequent performance. The variation is neglected not because there is no means of taking it into account, but rather because sufficient information on this vital factor is seldom available.

Vertical variation of permeability through the producing section is also very important. Where the variation is moderate this factor is taken into account by the assignment of a "displacement factor," usually about 80 per cent, which merely amounts to the assumption that for practical purposes about 80 per cent of the section carries the entire flow. The displacement factor may also be selected on the basis of an observed dry-gas breakthrough.

In cases where the vertical variation of permeability can be correlated throughout the reservoir, the results of the model study can be applied to each permeability stringer separately. A paper by Hurst and van Everdingen[7] shows how the results for the various stringers are to be combined.

Accuracy of the Results

In view of the many simplifications which for practical reasons are introduced into a model study, one might question the value of the entire work. In reality the results are checked by later experience in a surprisingly large number of cases, and surprisingly well. Very often the variations in permeability, which at first look too forbidding, average out over the large distances between the injection and the producing wells. In some cases the discrepancy between the predictions and later experience has led to a reexamination of the engineering or geological data, a new picture of the reservoir, and good agreement with the model. There are, of course, examples of complete failure. A paper by Marshall and Oliver[8] sets forth the extensive experience of these writers with the predictions of model studies in cycling, an experience by no means unfavorable.

It is entirely impossible to state categorically the limits of error of the electrical model. The model is nothing but a highly specialized calculating machine. Its inherent precision is much higher than the accuracy of data with which it is supplied; the error of the results is in the data and not in the calculations. At its worst the model demonstrates the error in the data. In many cases, however, the error in the data is not too important because the questions asked of the machine are of a comparative nature, such as which of two operating plans is likely to yield the higher recovery, what might be the advantage of drilling another well, or even what might be the consequence of a certain change in the fundamental assumptions on which the work is based. Such questions can frequently be answered with a much greater precision than the question as to the exact date of breakthrough in a particular well.

Other Applications

While the bulk of electrical model work in the past has dealt with gas cycling projects, the method has intrinsically a much wider scope. Artificial or natural water drives can be

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studied without any difficulty unless the dip of the formations and their permeability are so high that gravitational effects become important; the difference in viscosity between oil and water is largely compensated by a difference in relative permeability.

Even in gas-oil drives, such as the exploitation of an oil rim surrounding a gas cap, the method is of considerable use. It might seem at first that the large difference in viscosity and relative permeability would preclude such study. A detailed examination shows that the problem is not as difficult as would seem.

Summary

The analogy between Darcy's law and Ohm's law enables one to study the behavior of a secondary-recovery operation by means of an electrical model in which electric current is used in place of the fluids actually flowing in the reservoir. The model enables one to predict the manner in which the injected fluid will spread through the reservoir, the portion of the reservoir which cannot be flooded under a given well arrangement, and, in same cases, the composition of the produced fluid after breakthrough of the injected fluid. Practically all of the variables affecting production can be taken into account in the model. At the present time the electrical model is used extensively in cycling operations. Its potential applications are much wider.

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BOOKS

SELECTED VALUES OF PROPERTIES OF HYDROCARBONS. Circular of the National Bureau of Standards C461. Published by U. S. Department of Commerce and printed by the U. S. Government Printing Office. 483 pp. $2.75.

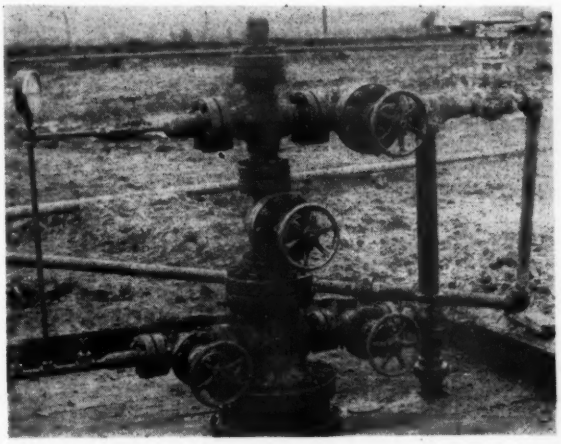
This volume represents a complete collection of all the numerical tables (as of May 31, 1947) issued by the cooperative research program of the American Petroleum Institute and the National Bureau of Standards known as the A.P.I. Research Project 44. The work springs from a proposal made in 1941 by the National Bureau of Standards to the A.P.I. that the two organizations establish a cooperative program on the compilation of tables of selected values of properties of hydrocarbons. The proposal was approved, and the new undertaking was begun in 1942. These tables are being extended to cover additional properties and additional compounds as rapidly as resources will permit.

Leduc rapidly becoming Canada's greatest oil reserve

by Neil Williams

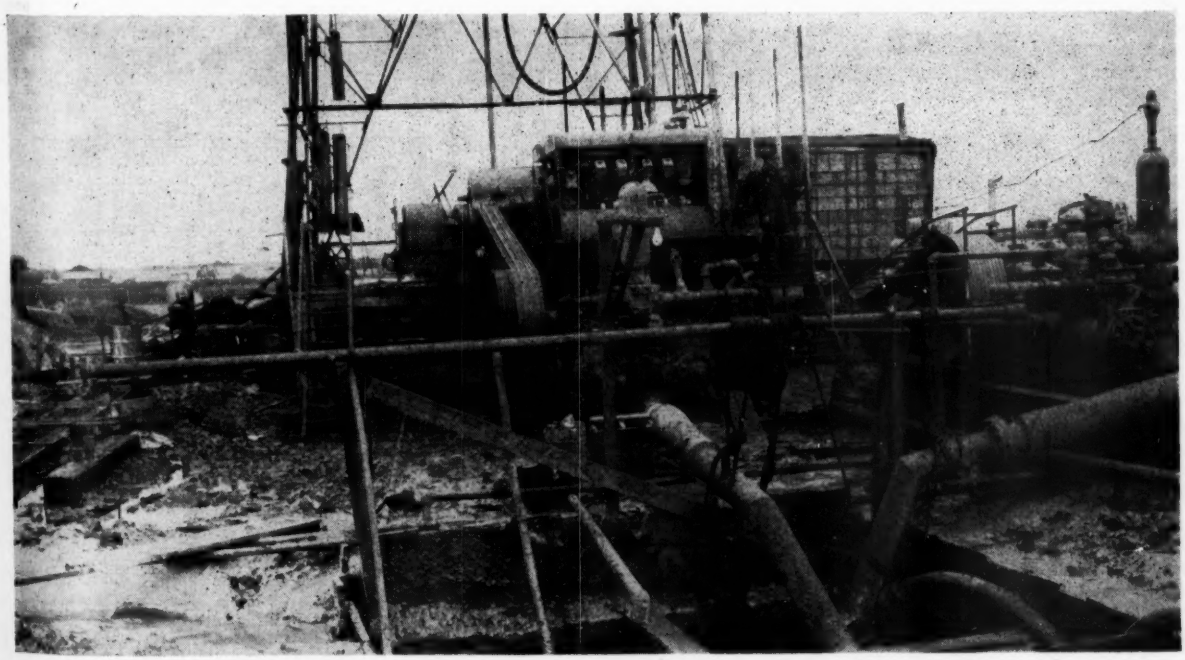
LEDUC field in central Alberta Province rapidly is being established as one of Canada's largest petroleum reserves so far uncovered and possibly one of the most important discoveries of the last several years on the entire North American continent. One year old February 13, its proved productive area, so far defined only on its east side, already embraces from 10,000 to 11,000 acres, extending approximately 5 miles from north to south and about 3½ to 4 miles from east to west. Currently, production is from two overlapping zones. Assuming these will have a combined ultimate recovery averaging from 7,500 to 12,000 bbl. per acre, reserves already proved are variously estimated from around 80,000,000 to more than 130,000,000 bbl.

Early in February, Imperial Oil Ltd., discoverer and principal operator in the field, completed a good well (1 Woodbend) about 3½ miles northwest of the present most northerly producer in the field. It is producing from the lower of the present productive horizons of the field and at approximately the same depth with about the same water level, but pending additional development it has not been determined whether it is an extension of the present producing area or opens a separate field with a possible saddle between them. Indica-

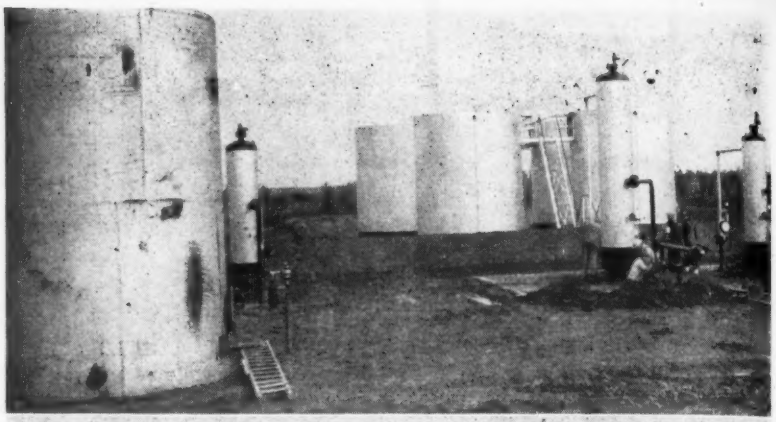


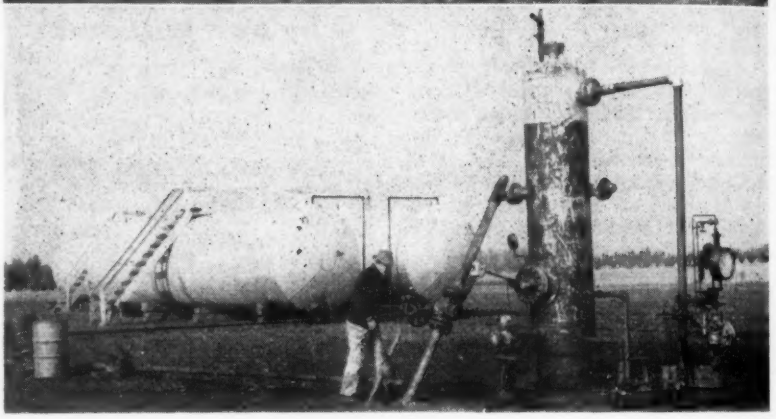
Right: Representative well-head hookup in Leduc field

Below: Drilling operation in Leduc field showing general type of rig and equipment being used



Central lease batteries are provided. In the top picture workers are tying in additional wells into newly completed battery. Tank at left is for water storage for boiler used in supplying steam for heating coils in oil tanks. Lower picture shows temporary flow hookup for discovery well. Horizontal tanks are now being replaced with standardized vertical tanks





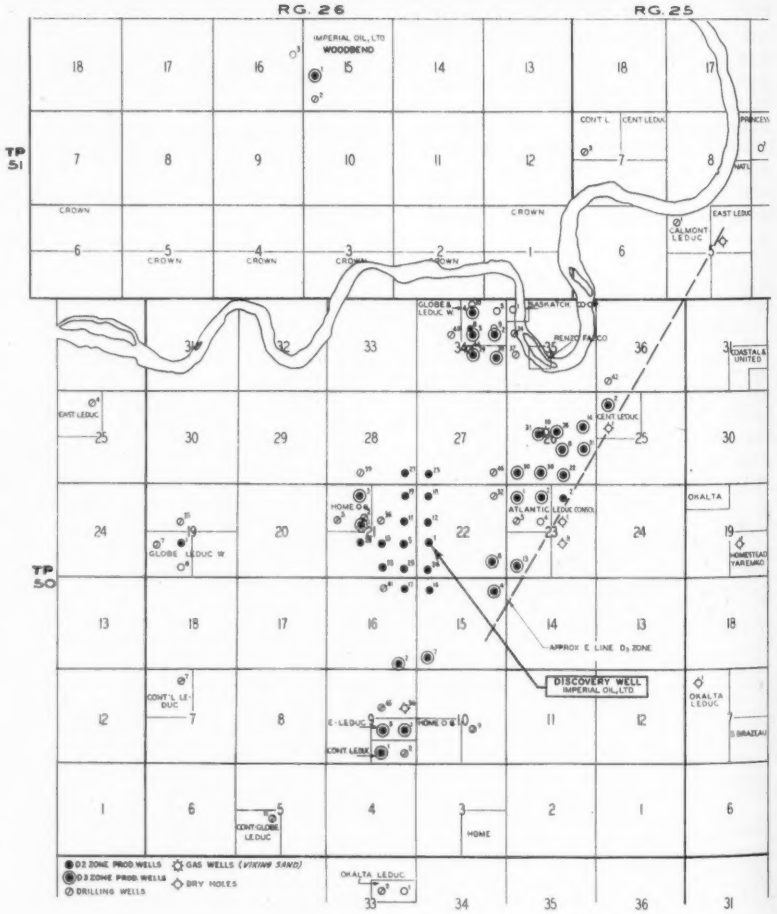
tions point to it being an extension, and if this is true it nearly doubles the present proved area and reserves.

At the end of the month 44 producing wells had been completed, exclusive of the Woodbend discovery. The drilling program calls for one well to 40 acres for each of the producing horizons. Where both zones are productive this will result in the drilling of two wells on each 40 acres, one to each zone. Due to pressure differentials and other factors it has not been considered advisable to produce both zones through a single well bore or to attempt dual completions in single wells. Although it has not been determined how much of the field will be productive from both zones it is conservatively estimated that the present proved area will require at least 450 wells exclusive of the potential area opened by the Woodbend well and by extension tests now drilling.

Development Expanding Rapidly

With the large extent and potentialities of the field becoming more generally recognized and an increasing number of operators being brought into the picture, the development program has been expanding rapidly. Twenty-five drilling rigs, including those on extension locations, are now running in the field. (Tables 1 and 4.) Two additional rigs are being moved into offset locations to the Woodbend discovery. These, with reductions being effected in drilling time per well due to the growing knowledge of structural, formational, and reservoir characteristics and ability of operators to eliminate much coring and preliminary testing, will result in a substantial increase in the completion rate. As compared with a time of 2 to 3 months on early wells, present wells are being drilled in from 25 to 35 days and completed in an over-all time of from 35 to 40 days. At this rate, without additional rigs, completions normally will average from 10 to 20 wells per month.

Potential flush flows of wells so far completed have ranged from approximately 500 to more than 2,700 bbl. per day. However, from the beginning most wells have been produced at greatly restricted rates. Prior to October, when Imperial placed in oper-



Map of Leduc field, including Woodbend extension area, showing development to March 1. All acreage and wells, except as otherwise indicated, are owned by Imperial Oil, Ltd.

TABLE 1—SUMMARY OF DEVELOPMENT, LEDUC FIELD (MARCH)

	Completions					Active rigs
	D2 zone	D3 zone	Total D2 and D3	Viking gas sands	Abandoned	
Atlantic Oils, Ltd.	..	2	2	..	..	1
Calmont-Leduc	..	..	..	..	..	1
Central-Leduc	..	1	1	..	1	..
Continental-Leduc	..	1	1	..	..	4
East Leduc	..	2	2	..	1	2
Globe-Leduc-West	2	3	5	..	..	2
Home Oils, Ltd.	..	2	2	..	..	1
Homestead	..	..	..	..	1	..
Imperial Oil, Ltd.	15	15	30	*1	1	13
Leduc Consolidated	..	1	1	..	2	..
Okalta-Leduc	..	..	..	..	1	1
Saskatchewan Co-op.	..	..	..	..	..	1
Total	17	27	44	1	7	26

*Gas well to supply field fuel needs.

TABLE 2—LEDUC PRODUCTION SUMMARY

	D2 zone		D3 zone		Total		Daily avg. prod. (bbl.)
	Prod. (bbl.)	No. wells	Prod. (bbl.)	No. wells	Prod. (bbl.)	No. wells	
February 1947	4,227	1	..	..	4,227	1	151
March	4,860	1	..	..	4,860	1	157
April	707	1	..	..	707	1	24
May	5,025	1	2,334	2	7,359	3	237
June	5,144	1	12,374	3	17,518	4	584
July	6,863	2	16,769	4	23,632	6	762
August	6,064	2	24,919	6	30,983	8	999
September	5,809	3	27,056	8	32,865	11	1,095
October	18,359	5	47,401	10	65,760	15	2,121
November	32,886	10	51,779	13	84,665	23	2,822
December	26,369	11	73,505	17	99,874	28	3,222
January 1948	35,324	15	82,255	23	117,579	38	3,793
Total	151,637		338,392		490,029		

ation an 8-in. pipe line to loading racks on the Canadian Pacific Railroad at Nisku, 8 miles from the field, production of wells was dependent entirely on availability of trucks. During that period roads into most locations were unimproved, and when the weather was bad it was impossible or difficult for trucks to reach the wells. Consequently, wells in many instances could be produced only intermittently, or at very low rates. Since December 15, production of individual wells has been restricted under a temporary order of the Petroleum and Natural Gas Conservation Board to 100 bbl. daily for those in the upper zone and 150 bbl. daily for those in the lower zone.

At the time the pipe line outlet was provided, daily production was averaging from 1,000 to 1,100 bbl. with 11 wells completed. Since then, with more regular production of wells possible and with the rapid increase in the number of wells completed, production has been boosted to more than 4,500 bbl. daily. Up to February 1, the field had produced a total of 490,029 bbl. (Table 2). January production alone totaled 117,579 bbl. as compared with 65,760 bbl. during October.

TABLE 3—PRODUCING-WELL COMPLETIONS BY MONTHS

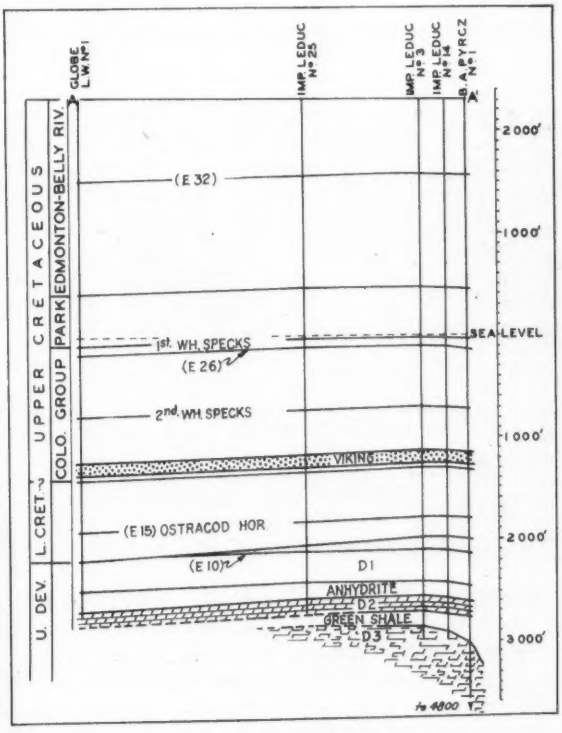
	D2 zone	D3 zone	Total
February 1947	1	..	1
March	..	..	..
April	..	..	..
May	..	2	2
June	..	1	1
July	1	1	2
August	..	2	2
September	1	2	3
October	3	2	5
November	4	3	7
December	1	4	5
January 1948	3	7	10
February	3	3	6
Total	17	27	44

Producing zones are in the Devonian formation, which prior to the discovery of this field had been explored in only a relatively few areas in Canada and found productive in only a few other fields (Princess-Steveville, Normal Wells, Ontario fields), about 200 miles southeast. Lying unconformably immediately below the Lower Cretaceous, it is topped at depths of from 4,295 to 4,450 ft. with surface elevations of from 2,300 to 2,400 ft.

In the section so far drilled there are three dolomitic limestone members, designated locally as the D1, D2, and D3 zones. The uppermost (D1) zone lies at the top of the Devonian. It is from 420 to 450 ft. thick and contains spotted porosity with irregular showings of heavy oil, gas, and water. Some heavy oil has been recovered in drill-stem tests, but so far no attempts have been made to complete any wells in it. However, it is considered probable that at some places, particularly with acidization, this zone eventually may prove productive.

The D2 zone, separated from the D1 zone by a shale and anhydrite interval of from 140 to 160 ft., is topped at depths of from 4,850 to 5,100 ft. and has an average thickness of approximately 150 ft. Saturation appears through the entire zone but porosity and permeability conditions generally have been best developed in the middle 50 to 60 ft., where most of the wells in the zone have been completed. Effective porosity of wells so far completed averages about 35 ft. Porosity pinches out toward the east and this is regarded as defining productive limits in that direction. No gas cap is present but there are indications of a water drive. Wells are produced with a solution gas-oil ratio of from 300 to 600 cu. ft. per bbl. Original reservoir pressure was around 1,770 psi.

Of the 44 wells in the field on February 13, 17 including the field's discovery well, were completed in the D2 zone. The discovery well (Imperial Oil, Ltd., 1 Leduc), located near the center of the present productive area of the entire field, topped the zone at 4,995 ft. (—2,634 ft.) and was stopped at 5,066 ft., 71 ft. in the zone where it had porosity from 5,029 ft. Although wells within ¾ to 1 mile east of the discovery well have found porosity pinched out, production in



Cross-section of part of Leduc field

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this zone has been extended more than 2 miles to the west, approximately 3 miles to the north, and about 1 mile to the southwest, with limits in these directions still undefined.

Unlike the D1 and D2 zones, which are broad depositional beds dipping monoclinally from east to west into the Alberta Basin, the D3 zone is believed to be a coral-reef formation. It is topped at depths of from 5,200 to 5,400 ft. and is separated from the D2 zone by a green shale member. All of the section drilled so far has shown good porosity and wells so far completed generally have a much higher potential productivity than those in the D2 zone.

Discovery well of this zone was Imperial 2 Leduc, located about 1½ miles southwest of 1 Leduc, the D2 zone discovery well. It topped the D2 zone at —2,691 ft., only 57 ft. lower than 1 Leduc, but found this zone too tight to produce. Drilled deeper as an exploratory test, it topped the D3 zone at —2,979 ft. Hole was carried to —3,027 ft. (actual depth 5,423 ft.), 48 ft. below the top and 10 ft. below where water first was encountered (—3,017 ft.), leaving it 36 ft. of oil saturation. It was plugged back to —3,014 ft. (5,410 ft. actual depth), 1 ft. above the water. Casing, cemented on bottom, was perforated at —2,986-98 ft., a minimum of 16 ft. above the water where the well has been producing clean oil.

Above a subsea depth of approximately 2,980 ft., the zone carries gas. With water level established at a subsea depth of between 3,015 and 3,020 ft., there is a maximum of from 35 to 40 ft. of oil saturation. Maximum penetration of the zone within the present producing limits has been approximately 140 ft. This has been in some of the structurally highest wells located along the east side of the field where as much as 125 to 130 ft. of gas section is present. All wells have casing set through the gas into the oil zone, but, on the basis of drill-stem tests, wells in the gas-cap area have gas producing potentials of from 30,000,000 to 40,000,000 cu. ft. daily. Original reservoir pressure of this zone was approximately 1,895 psi.

Eastward limits of the D3 zone apparently are defined by an abrupt reverse dip in the formation along that side of the field. This first was indicated in a well (1 Pyrcz) drilled by Central Leduc Oil Co. and British American Oil Co., which, although only one location east of one of the highest wells (Imperial 14 Leduc) in the zone, found the top of the formation at the water line, a drop of about 113 ft. This well had run normally high in the D2 zone, which lacked sufficient porosity at that location to produce, but in drilling to the D3 zone found the green-shale interval between the zones had thickened. It subsequently was drilled as an exploratory test to a total depth of 7,006 ft. (—4,696 ft.) where it was abandoned.

Evidence of Dip

Further evidence of this abrupt dip was given in two wells drilled simultaneously by Leduc Consolidated. One of these wells (No. 2), located approximately ¾ mile southwest of the Pyrcz test and also offset to the west by high wells, topped the D3 zone at —3,012 ft. (5,358 ft. actual depth), only 5 ft. above the water line, assuming —3,017 ft. as the contact. In view of the proximity of the water, it was drilled only 1 ft. into the formation, and there completed as a small producer. A straight line drawn through this and the Pyrcz wells would establish the dip and eastern limits of production as following a southwestern-northeastward trend.

The other Leduc Consolidated test (No. 1) was one location south of No. 2 which would place it slightly farther east of the southwest trending dip. It was drilled to a total depth of —3,050 ft. (actual depth 5,402 ft.), or from 30 to 35 ft. below the water level, without getting the D3 zone, and where it was abandoned still in the green shale section. A third test, one location farther south, was drilled by this company about the same time but being still farther east of the trend of the dip, it was abandoned in the D2 zone after finding this zone too tight to produce. Since then another test (East Leduc Oils 2 Leduc), located about 2 miles northeast of the Pyrcz dry hole and along a line extending through the latter and the Leduc Consolidated tests, failed to get the D3 zone, indicating a continuation of the dip in that direction.

Eastward limits of the D3 zone, as defined by the dip, extend from ¾ mile to a mile east of where the porosity pinch-out occurs in the D2 zone. Production in the D3 zone already has been extended westward under the D2 zone a distance of more than 2 miles from these limits, and as much as 5 miles westward if Imperial's Woodbend discovery is included as a part of the field.

Twelve different companies or operating groups are now active or preparing to start work in the field. Except for one company rig operated by Imperial, all drilling at present is being done by drilling contracting companies with eight different companies represented. Development status of the field as of March 1 showing operating companies and drilling contractors is indicated in accompanying tabulations.

General drilling practice calls for the use of from 300 to 320 ft. of 9⅝ or 8⅝-in. surface casing and 5½-in. production string (to conserve steel), cemented at the top of the oil saturation. Wells are started with 20-in. conductor pipe set in hand dug hole 3 to 4 ft. below the bottom of the cellar. The 5½-in. casing is run in 7⅞-in. hole, drilled through the zone in which the well is to be completed. In the case of D3 zone wells, the hole is bottomed with a safe margin, usually about 10 ft., above the water contact when possible, and the casing landed at a point below the gas-oil contact. In a few wells which happened to drill to the water contact, casing has been run through the zone and then perforated, but this practice is not expected to be followed, except under these circumstances. In cementing the production string every effort is made to pump enough cement behind the string to place the top above a water sand just above the top of the Devonian.

Development has reached a point that it has become possible, particularly on inside wells to place greater dependency on electric logs for determination of zones of porosity and productivity, and thus eliminate much coring and drill-stem testing that previously has been required. Until comparatively recently it was not unusual to core as much as 1,000 to 1,500 ft. and make as many as 20 to 25 drill-stem tests in a well. Coring now has been reduced in many cases to less than 100 to 200 ft. and drill-stem tests to not more than 4 or 5. At least one company has gone so far as to eliminate all drill-stem tests in some wells. Both wire-line and conventional coring have been practiced with 7⅝-in. heads being used for the former and 6⅛-in. heads for the latter.

Formations are relatively hard and require rock-bit drilling from the surface. From 20 to 30 bits are used. Formations are fairly flat, however, and no difficulty is experienced in keeping holes straight.

Drilling into the producing zones is complicated by the necessity for maintaining a relatively close balance of

(Continued on page 113)

TABLE 4—DRILLING CONTRACTORS AND RIGS IN LEDUC FIELD

Contractor—	Imperial Oils Ltd.	Atlantic Oils	Okalta Leduc	Globe Leduc West	Home Oil	Continental Leduc	East Leduc Oils	Sask. Co-ops	Calmont Leduc	Tot.
Can-Tex Drlg. Co.	2	..	..	..	..	..	..	..	..	2
Commonwealth Drlg. Co.	2	..	..	..	..	..	..	1	..	3
Drilling Contractors, Ltd.	4	..	..	..	1	..	..	..	..	5
General Petroleum, Ltd.	3	1	..	..	..	1	..	..	..	5
Northern Dev. Co.	..	..	..	1	..	3	1	..	..	5
Regent Drlg. Co.	..	..	..	1	..	..	..	..	..	1
Wilson, Whitey	..	..	..	..	..	..	1	..	..	1
Young Drlg. Co.	1	..	..	..	..	..	..	..	..	1
Company rigs	1	..	1	..	..	..	..	..	1	3
Total	13	1	1	2	1	4	2	1	1	26

DU PONT ADDITIVES... add the QUALITIES

you want to your Fuels and Lubricants

This partial list of Du Pont fuel and lube oil additives is indicative of the results of a continuing program to produce new and better additives. Each has been produced to meet a specific need . . . to add to or enhance the desirable properties of petroleum derivatives, or to arrest or inhibit deterioration caused by oxidation, polymerization, or metal entrainment. Write for complete information. E. I. du Pont de Nemours & Company, (Inc.), Petroleum Chemicals Division, Wilmington 98, Delaware.

NAME	DESCRIPTION	USE
"Fluoroleum" Green Paste	Oil-soluble dye in paste form.	With "Fluoroleum" Red Paste for imparting desirable green fluorescence to oils of unsatisfactory appearance.
"Fluoroleum" Red Paste	Oil-soluble dye in paste form.	With "Fluoroleum" Green Paste for imparting desirable green fluorescence to oils of unsatisfactory appearance.
Du Pont Gasoline Antioxidant No. 5	A solution of normal butyl-para-aminophenol in alcohols.	For reducing the formation of gum and improving the stability of leaded gasolines.
Du Pont Gasoline Antioxidant No. 6	A solution of isobutyl-para-aminophenol in alcohols.	For reducing the formation of gum and improving the stability of leaded gasolines.
Du Pont Gasoline Colors	Du Pont Oil Orange Du Pont Oil Red Du Pont Oil Yellow N Du Pont Oil Blue	For color identification of gasolines.
Du Pont Metal Deactivator	An 80% solution of N,N'-disalicylidene-1,2 diamino-propane in xylene.	For improving the storage stability of petroleum distillates containing dissolved copper.
Du Pont Rust Preventive No. 1	A viscous, reddish-brown clear liquid, readily soluble in mineral oil at room temperatures.	At concentrations of 2-5% by volume in petroleum bases for imparting non-staining rust preventing properties.
"Ortholeum" 153	Fluorescent green liquid.	At concentrations up to 1% in motor oils and other lubricants to improve wear characteristics under conditions of boundary lubrication.
"Ortholeum" 202	A sulfurized terpene containing approximately 34% sulfur of controlled activity.	As a sulfur carrier where moderate sulfur activity is desired.
Du Pont Phenyl-alpha-naphthylamine	Crystalline solid.	Oxidation inhibitor for various products.
Du Pont Phenyl-beta-naphthylamine	Powder.	Oxidation inhibitor for various products.
Du Pont Tributyl Phosphite	Water-white liquid.	At a concentration of about 0.5% in oils as a mild antioxidant and as a wear reducing agent.
Du Pont Tetraethyl Lead Compound—Motor Mix	Yellow liquid antiknock compound the principal component of which is tetraethyl lead.	In concentrations up to 3.0 cc./gallon as an antiknock agent for motor gasolines.
Du Pont Tetraethyl Lead Compound—Aviation Mix	A blue liquid antiknock compound the principal component of which is tetraethyl lead.	In concentrations up to 4.5 cc./gallon as an antiknock agent for aviation gasolines.
Du Pont Fuel Oil Stabilizer No. 1	A blend comprising an antioxidant and metal deactivators in isopropanol.	Added to cracked furnace and diesel oils in concentrations of 0.001 to 0.01% by weight to improve storage stability.

Gasoline Oxidation Inhibitors
Oil Soluble Colors
Lubricating Oil Additives
Fuel Oil Additives
Metal-Working Lubricants
Corrosion Inhibitors

PETROLEUM CHEMICALS

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BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

MAINTENANCE OF ORIFICE METERS

by E. D. Nuneviller and D. M. Considine†*

THE orifice meter is probably the most criticized of industrial instruments, and unjustly so. Orifice meters are designed and built for industrial use and will faithfully record the differentials impressed upon them, if all conditions of installation have been properly handled. Too often on the initial installation of the orifice meter and associated equipment, the basic principles of complete and satisfactory installation are ignored. Many times, existing flanges are used both in new and old lines to save the cost of new flanges, when it is known that the existing flanges do not have the proper upstream and downstream straightrun of piping for efficient orifice operation.

Installation of the orifice plate is not always given the consideration it should have and too often the orifice plate is not located concentric with the pipe bore. The gaskets must not cover part of the orifice opening. Extreme care must be exercised in tightening the flange bolts so as not to buckle the orifice plate. Connecting piping includes all valves, fittings, and condenser pots between the pipe line and the meter body and is an important part of the over-all installation.

*Supervising service engineer and †application engineer, Brown Instrument Co.

Condenser pots must be level. There must be no leaks at valves or at pipe connections. The meter body must be free from vibration and mounted level.

Importance of Planning and Maintenance

Actually good flow metering on a new installation should start with the schematic layout. The orifice locations should be given the same consideration that is given to the proper location of thermocouples, thermometer bulbs, pressure connections, and locations of automatic-control valves. It should be the responsibility of the instrumentation engineer to select the proper orifice locations on the diagram and to follow through on the construction work to make sure that all orifices are located in the piping as he originally designated.

The maintenance of flow meters should be delegated to individuals who have been properly trained in this class of instrument work and they alone should be permitted to make meter adjustments. These men should also supervise meter installations from start to finish, as construction men are often prone to disregard or ignore the requirements of a good meter installation. To assure accurate metering at all times, once an installation has been made, it is urgently recommended that a definite periodic maintenance program be established and followed consistently. A periodic checkup will result in most accurate measurement over a longer period of time than where nothing is done until trouble occurs.

Orifice Plate and Connecting Piping

The orifice plate is the primary or detecting element and is installed in the pipe line proper. A great number of tests over a period of years have proved the accuracy of the thin-plate orifice for measuring flow, provided it is installed correctly and there have been no changes in its size or shape.

To obtain accurate results with a thin-plate orifice, it must remain flat, the upstream edge must be sharp and square, free of corrosion and pitting, have no accumulation on the upstream side, and there must be no increase in the size of the opening. Periodic inspection of the plate is advisable and should always occur whenever there is a shutdown. Some of the common causes of error due to orifice plates are shown in Figs. 1 and 2.

If the plate has a rounded upstream

TABLE 1—GENERAL TROUBLE-SHOOTING CHART FOR ORIFICE METERS

Trouble encountered	Possible causes
Changing zero	Leaks in connecting lines, meter body, etc. Meter body not level. Entrained air in meter body (liquid or steam flow). Condensate in meter body (steam flow). Meter body range tube and float chamber walls coated with dirt. Excess friction of pen on the chart. Excess friction in pen shaft, connecting links and pressure-tight bearing.
Sluggish meter operation	Orifice nipples, connecting piping and/or meter body clogged with dirt.
Meter reading high (Integration and zero check "OK")	On gas flow—condensate in the high-pressure piping side. On steam flow—low-pressure condenser pot below level of high-pressure pot. On vertical downward lines—low-pressure bent orifice nipple filled with condensate instead of steam; condenser pot volume too small. On liquid flow—entrained air in low-pressure piping side. Sealing fluid contaminated. Orifice plate warped or upstream edge wire drawn.
Meter reading low (Integration and zero check "OK")	On gas flow—condensate in the low-pressure piping side. On steam flow—high-pressure condenser pot below level of low-pressure pot. On vertical upward lines—high-pressure bent nipple filled with condensate instead of steam; condenser pot volume too small. On liquid flow—entrained air in the high-pressure piping side. Sealing fluid contaminated. Seal pots not leveled. Leakage past the meter-body equalizing valve. Orifice plate with rounded upstream edge or an accumulation on plate. Warped plate.

XUM

edge, or if it is warped or wire drawn, the only means of correction is replacement. An accumulation on the upstream edge can be removed and it is recommended that this be done by the use of solvents rather than by filing or scraping. Use of solvents will eliminate the possibility of rounding the upstream edge. If the accumulation cannot be dissolved, a large flat stone should be employed and then only on the plate faces.

If the plate is damaged, the cause should be determined and the necessary remedies made. For example, a bulged plate may be due to the action of slugs of condensate which have collected in low spots in the line when it was down and which were blown against the plate when stream was again turned on.

In reinstalling the plate, the square edge of the orifice opening must be upstream and the plate located concentric with the pipe bore. Incorrect centering of the orifice plate can cause either high or low meter readings, depending on how the plate is centered with reference to the taps. The outside circumference of the pipe flange provides the most convenient measuring point for centering the orifice. The outside circumference, however, is often eccentric to the inside circumference of the pipe. To check this possible error, three equally spaced measurements between the inside of the pipe and the outside of the flange, as shown in Fig. 3 should be made.

The orifice should then be inserted, after which another set of measurements at the same locations between the outer edge of the orifice plate and the outer circumference of the flange should be made, as shown at the right in the figure. The plate should be shifted until the difference between the two sets of measurements for each of the three locations is the same, That is, referring to Fig. 3, the following relations should exist: A — D = B — E = C — F. For this condition, the orifice plate will be centered with the bore of the pipe. Permit the orifice tab to protrude above the pipe lagging so that the serial number and size may conveniently be checked if found necessary.

Maintenance of Connecting Piping

The connecting piping includes all of the valves, fittings, condenser pots, and seal pots between the pipe line and the meter body. Maintenance of this piping system includes the periodic checking for:

1. Leaks at pipe connections, valves, and meter body joints.—The smallest leaks will result in incorrect differential pressures on the meter body with subsequent errors in flow readings.

2. Levelness of condenser and seal pots.—Incorrect leveling results in false differentials on the meter, which can only be detected under conditions of zero flow. The error will not be evidenced by normal zeroing (equalizing) of the meter body. The error exists, however, and it is extremely important that correct level be maintained.

3. Clogging of connecting lines.—Connecting lines must be blown down to keep them free from clogging, which results in sluggish meter operation. The installation of auxiliary blowdown lines facilitates this work.

4. Venting of piping.—On liquid installations, the connecting piping should be arranged so that it will be self-venting. The lines should be checked periodically to determine whether they are air or gas bound. If high spots must be located in the lines, suitable vents must be provided and these should be opened regularly to release trapped gases.

5. Drainage of piping.—On gas installations, the connecting piping should be self-draining, normally back to the flow line. The lines should be checked periodically for trapped liquids.

6. Contamination of sealing liquids.—On installations employing seal pots, periodic checks should be conducted to make certain that the flowing medium is not contaminating the sealing fluid. This procedure is best accomplished by comparing a sample of sealing fluid drawn from the seal pot with a sample of the pure sealing fluid. The two liquids can be collected in test tubes or glass bottles and so compared. The sealing fluid sample can be obtained from the seal pots at one of the various try-cock levels. Where sufficient contamination is noted, both the seal pots and the meter body should be cleaned and refilled with fresh sealing liquid.

Where any of the above maintenance is performed, do not attempt to check the instrument on zero until sufficient time has elapsed to permit stabilization of the equipment at normal operating conditions. Zero checks should always be made under line pressure.

Faulty installation of the taps is a common source of orifice meter errors. The two most common errors are (1) projecting of the pipe tap nipple beyond the inside pipe wall, and (2) leaving burrs in the pipe, as a result of the drilling and tapping operations. Both of these factors can cause serious errors. It is essential, therefore, that the installation be checked carefully after the pipe fitter has completed his work.

When removing burrs, the tap opening should be slightly beveled. However, care should be exercised so that the pipe surface is not roughened during the filing operation. A half coupling welded to the pipe provides

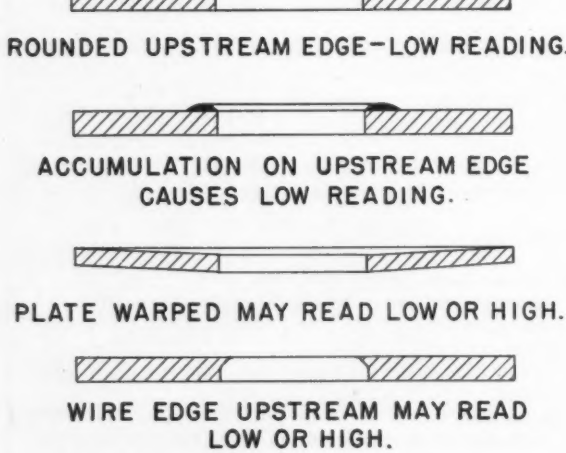

ROUNDED UPSTREAM EDGE—LOW READING.
ACCUMULATION ON UPSTREAM EDGE CAUSES LOW READING.
PLATE WARPED MAY READ LOW OR HIGH.
WIRE EDGE UPSTREAM MAY READ LOW OR HIGH.

Fig. 1—Orifice plates, some common causes of error

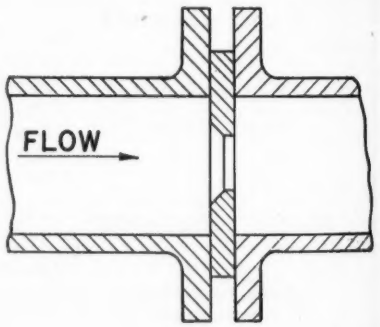


Fig. 2—(Right) Bevel on wrong side, meter low

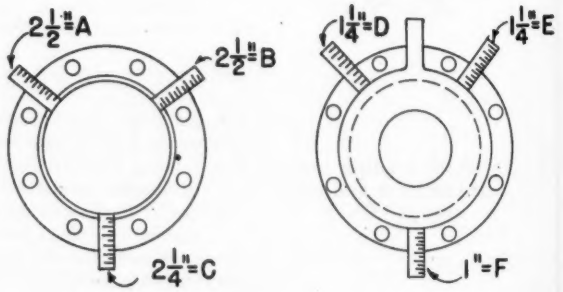


Fig. 3—Method of centering of orifice

an ideal method of installation. If couplings are not available, a base built up by depositing weld metal on the pipe wall should be used.

Two additional sources of error are illustrated in Fig. 4. A flash or icicle which often occurs when a welding neck tapped orifice flange is installed is shown at the left. When this type of flange is used, the installation should be checked carefully and the flash knocked off and filed smooth. To eliminate this difficulty, many large users specify the use of slipon flanges. Another source of error, caused by the recess between the tap and the plate, formed when the pipe is not screwed up flush with the face of the flange, is shown at the right. While this error is not great, seldom exceeding 1 per cent, the error is serious where large volumes of fluid are being measured for accounting purposes, such as distribution of gas.

Meter Body

If the meter is to indicate accurately the correct differential across the orifice, its body and mercury must be comparatively clean. Assuring these conditions involves the checking of meter-body zero, cleaning, and checking calibration. Details of the maintenance program include:

1. The meter body should be equalized and checked on zero at least once a week. Any tendency for the zero to drift continuously up or downscale or suddenly to shift is indicative of trouble. It may be due to leakage, the meter body not being level, connecting-line troubles, dirt in the meter body, or occasionally contamination of the mercury. If zero changes of this nature occur and a check of the connecting-line system shows it to be in order, the meter body should be disconnected and cleaned.

2. In cleaning the meter body, experience, depending on the type of fluid measured, usually will determine how extensive a job must be performed. If the meter body contains only silt, loose scale, or mud, a thorough flushing with a high-pressure water line will usually suffice. To do this, disconnect the meter body, drain off the mercury and, if an electrical type, turn off the power and disconnect the leads. Connect a high-pressure water line to the low-pressure side of the meter body and allow the water to flow through until sediment is removed.

If the meter body is filled with a greasy or oily sediment, it should be dismantled and cleaned with solvent. In reassembly, make certain to replace all gaskets.

When cleaning the mercury, if badly amalgamated, it should be replaced. However, if facilities are available to either distill or purify it by washing with acid, this procedure will be more economical. In the majority of cases, it can be cleaned by washing thoroughly with water and then filtering through a fine chamois cloth.

3. The meter-body calibration should be checked regularly. Before this is done, however, the meter body must be cleaned and a suitable standard check column must be available. The type of standard column to make up will depend upon the facilities available, and upon the differential range of the meters which are to be checked.

An arrangement for use on meters having differentials above 20 in. of water and which are to be checked for "wet" calibration, that is, with water above the mercury, is illustrated in Fig. 5. In making up the column, it is best to use ½-in. i.d. or larger glass tubing to reduce meniscus effect and subsequent errors in reading. The water-supply tank must be located above the highest point of the column proper. In filling the system, use distilled water. If this is not available, make certain that all air is expelled from the water used and that no air pockets are present in the system. The meter body must also be carefully filled with water and all entrained air expelled. The presence of air in either the water column or meted body will give erroneous results.

The arrangement shown in Fig. 6 can be used as a permanent apparatus, where compressed air is available and a large number of meter bodies are

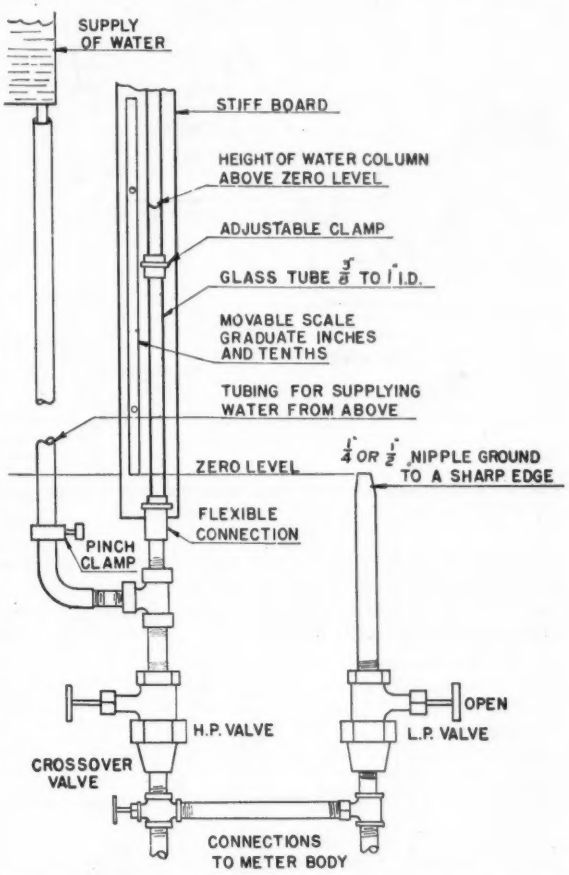


Fig. 5—Arrangement for "wet" calibration of meters having differentials above 20 in. of water

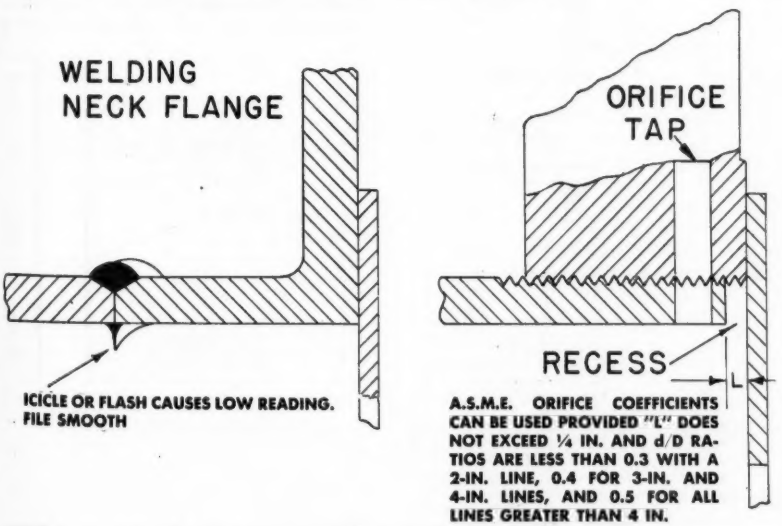

WELDING NECK FLANGE
ICICLE OR FLASH CAUSES LOW READING. FILE SMOOTH
ORIFICE TAP
RECESS
L
A.S.M.E. ORIFICE COEFFICIENTS CAN BE USED PROVIDED "L" DOES NOT EXCEED ¼ IN. AND d/D RATIOS ARE LESS THAN 0.3 WITH A 2-IN. LINE, 0.4 FOR 3-IN. AND 4-IN. LINES, AND 0.5 FOR ALL LINES GREATER THAN 4 IN.

Fig. 4—Orifice flanges, two possible sources of error

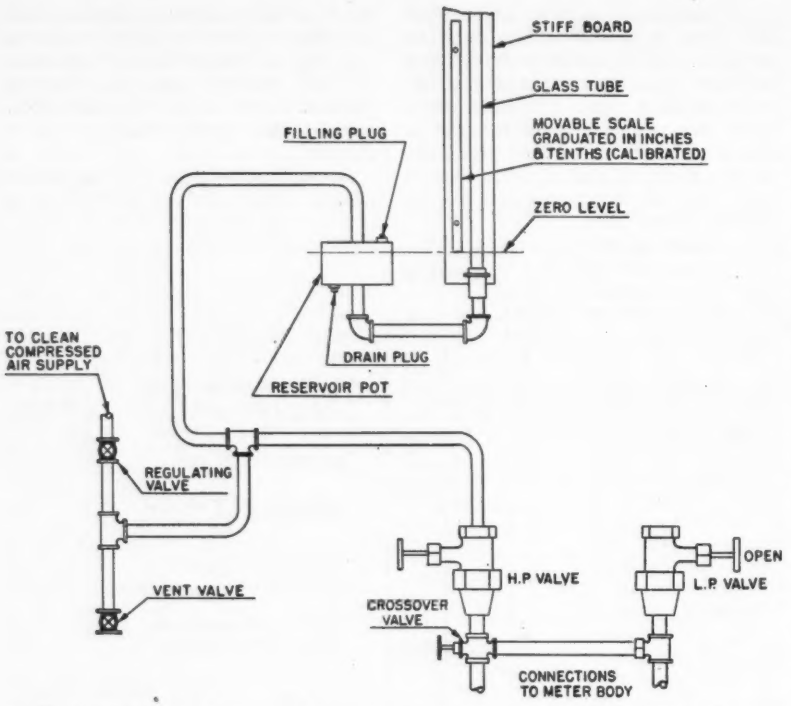


Fig. 6—Arrangement of permanent apparatus where large number of meter bodies are to be checked

to be checked. To cover a full range of differentials from 20 in. of water to 36 in. of mercury, three such columns should be built, as follows:

No. 1 using water, having a scale about 3 ft. long. This should use ½-in. i.d. glass tubing and a reservoir pot about 8 in. in diameter. The pot and pipe fittings should be of brass.

No. 2 using a reasonably stable liquid having a specific gravity of about 3.00 compared with water, such as tetrabromoethane, with a 3-ft.-long scale. This should use about ¼-in. i.d. glass tubing and a reservoir pot about 4 in. in diameter. The pot and pipe fittings should be of brass. This will handle differential ranges from 30 to 100 in. of water.

No. 3 using mercury with the same tubing, scale, and pot size as given for No. 2, except the pot and fittings should be of steel. This will be suitable for differentials above 100 in. of water.

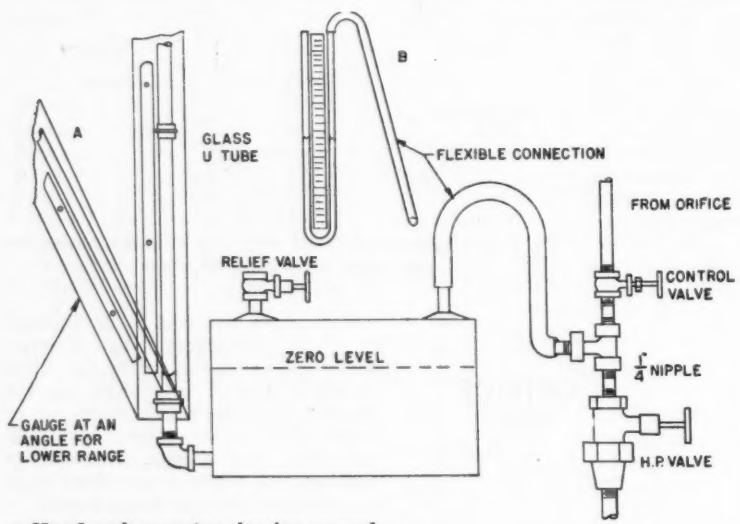
On all three units, the scales should be calibrated by using a water column connected in parallel with the test column. This will assure absolute accuracy of the test columns over normal ambient temperature variations. The specific gravity of the liquid used in the No. 2 column must be maintained at the same value or the column will be in error.

In employing the above columns, the meter body is "dry" or in other words, there is no liquid medium above the mercury.

An arrangement, shown in Fig. 7, employing an included glass tube (A) can be used on differentials below 20 in. of water. Such low-differential meters are normally used to measure gas and as such are "dry" calibrations. The pressure to actuate the column can be obtained from the gas line, as shown, or from a compressed-air line. The glass tube should be about ½-in. i.d. and the reservoir pot about 8-in. diameter. The vertical tube or the U-tube (B) can be used in place of the column shown in Fig. 7, when dry checks are to be made on meters having differentials above 20 in. of water.

In making a water-column check, a 0-100 square root or evenly graduated chart should be placed on the meter. Check the pen tension on the chart to determine if it is excessive, since this will introduce tapping error. A reasonable check consists in making certain that the pen lifts off the chart when a slight inward pressure is exerted on the chart and chart plate. Next set the pen to exact zero. Increase the pressure by unit steps of 10, 20, 30, etc., up to 100 on the chart and at each step, make a chart record of the reading.

This should be repeated going downscale. The check should be made unidirectional, that is, all water-column settings should be made progressively upward on the upscale



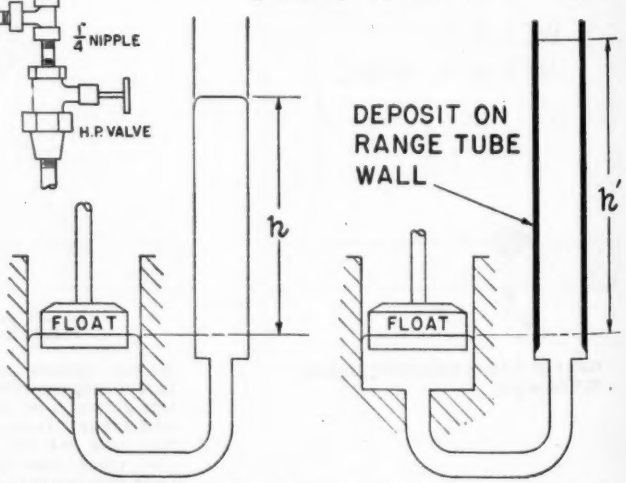


Fig. 7—(Above, left) Layout for checking differentials below 20 in. of water, via "dry" calibrations. Fig. 8—(Above) Effect of dirty range tubes

check and progressively downward on the downscale check. The average of these readings, if within the normal accuracy guarantee of the meter, will give the true reading of the meter, since the flow being measured is continuously increasing or decreasing. If, however, the differences are greater than the allowable errors, excessive friction is present and should be removed. This may be due to pen-shaft friction, excess pen tension, bent connecting links, or if a mechanical-type meter, excess friction in the pressure-tight bearing.

In reading water columns, the eye should be level with the top of the liquid in the column so as to reduce parallax errors. To determine the correct differential at any cardinal point on the chart, use the following formulas:

Evenly graduated charts:

$$\text{(Differential at chart reading "X")} = \text{(Maximum meter differential)} \left(\frac{\text{Chart reading "X"}}{\text{Full-scale chart reading}}\right)$$

Square-root flow charts:

$$\text{(Differential at chart reading "X")} = \text{(Maximum meter differential)} \left(\frac{\text{Chart reading "X"}}{\text{Full-scale chart reading}}\right)^2$$

Dirty range tubes.—The effect of dirty range tubes is shown in Fig. 8. Assume that the flow meter is a controller and that the control point is 80 per cent of full scale. With a clean meter body, the float will assume the position as shown at the left of the rise in mercury will be h. If the range-tube walls become dirty, decreasing the effective area, the height of the column must increase to h′ with the float in the same position as when the meter body was clean. Under these conditions, the flow will be greater in the ratio of $\sqrt{h'/h}$ for the same control set point.

In those types of meters where the square root is extracted by the shape of the range tube, the zero level is very important since there is a very definite starting point. The exact amount of mercury required is generally stamped on a plate fixed to the meter body, and changes in mechanical adjustments to make the meter read correctly at zero should not be made without checking the mercury column.

In many mechanical and electric meters using straight-walled mercury chambers, some variations in mercury level can be compensated for by either mechanical adjustments that are provided in the instrument linkage or shifting the coil position. Care must be taken not to make too many corrections for loss in mercury or the level may become so low that full-scale float travel cannot be obtained.

General Considerations

On mechanical-type meters, inject a small amount of grease into the pressure-tight bearing every week.

The chart and integrator factors on any orifice meter can be correct for only one set of operating conditions. For this reason, it is a definite part of the maintenance program periodically to check the operating conditions, including pressure, temperature, specific gravity, and moisture, so as to determine if variations do occur. If found necessary, corrections to the chart and integrator factors should be made. If variations are of large magnitude and at indefinite times, it is advisable to install recording meters so as to obtain daily records of these variables and then make daily corrections.

If the flow is found to exceed the chart range regularly, or if it never goes above 70 to 75 per cent of the flow range, the meter differential or the orifice plate should be changed to bring the normal flow record to a better position on the chart.

Leduc Rapidly Becoming Canada's Greatest Reserve

(Continued from page 105)

mud weight to prevent loss of mud into these zones and at the same time to control gas pressures in the Viking sand encountered at depths of 3,400 to 3,500 ft. in the base of the Upper Cretaceous section. Although pressures in the Viking sand are not abnormally high, a mud weight of from 9.5 to 10 lb. per gal. normally is required to hold them. However, porosity and pressure conditions in the producing zones of most wells are such that if a weight of much more than 9.5 lb. per gal. is carried, loss of circulation will result. Even with this low weight, loss of circulation sometimes occurs, and with mud loss, regardless of the weight, the hazard of a blowout from the Viking sand is increased.

The mud conditioning program also calls for holding the water loss below 8 to 10 cc. and viscosity from 40 to 45 seconds. Commercial gel muds are used and desired properties are fairly easily controlled by caustic, quebracho, and soda ash treatment, except when drilling through an anhydrite section, about 100 to 150 ft. thick, in the interval between the D1 and D2 zones. There the mud has to be watched very closely and treated with barium sulfate or comparable chemicals to prevent contamination that might result in increasing the water loss and building up filter cake to stick the pipe.

All wells so far completed have been brought in by natural flow. However, to bring a well in it usually is necessary to circulate the hole with oil piped from the nearest battery, and then gasify the oil column by injecting gas piped from the casing head of the nearest available producing well. In the completion procedure, the drilling mud in the hole, after plug is drilled, first is displaced with water, and then the water is displaced with oil circulated through the casing. A light, skid-mounted reciprocating pump which can be moved easily from one location to another as needed usually is provided for this purpose.

Some wells may come in after swabbing the oil column or even the water displaced mud but in the majority of instances it is necessary to gasify the column. There usually is from 1,000 to 1,500 psi. of gas pressure available for this purpose. The gas is injected through the oil line into the casing head and usually requires only from 2 to 3 hours to lighten the oil column sufficiently to start the well flowing. Wells generally are produced through open tubing for the first few hours to clean them thoroughly and gage production for potentials, after which they are placed on regular production through chokes. Flowing pressures through tubing chokes run from 400 to 600 psi.

Gravity of the oil produced ranges from 38° to 40° (A.P.I.). However, it has a low gel and pour point (about 10° F.) and congeals in cold weather. To facilitate handling in winter, lease tanks are equipped with steam coils, and a small boiler or water heater is set up at each battery to provide the steam. Water for this purpose usually is obtained from shallow wells (about 150 ft. in depth) drilled at each battery.

Both power and steam rigs are being operated in the field although power rigs predominate. A part of the gas-fuel requirement is supplied from a well (10 Leduc) drilled by Imperial to the Viking gas sand especially for this purpose. Water for drilling purposes is obtained from the North Saskatchewan River, which flows through the field. A central water distribution system has been provided by private operators, from which the water is sold to the various drilling contractors and operating companies where needed. Well costs have averaged from $65,000 to $75,000.

QUESTIONS on TECHNOLOGY

by W. L. Nelson

Consulting Engineer

Recovery of Solvent From Air

In our . . . refinery we have a considerable loss of hexane gas. The gas is a mixture of air and hexane vapor so all the hexane will not condense at normal condenser temperatures. We are considering the use of an adsorbent such as activated carbon. I would appreciate it if you could advise me of any literature on the subject.—S. E. C.

There are three general methods of recovering solvents from air or inert gases:

1. Compression and cooling, or occasionally cooling alone. This method is particularly suited to very rich mixtures or to mixtures in which the solvent has a high boiling point. Fig. 1 indicates the approximate condensing temperature of several air-hexane mixtures. Examination of this figure shows definitely that extremely high-pressure or very low temperatures are required if the recovery of hexane is to be reasonably complete. However, it is also obvious that cooling and/or compression and cooling is the best method of handling exceedingly rich mixtures and that this method would be used as a preliminary method of treating such mixtures. From this standpoint compression and cooling is the basic recovery method. The two horizontal dashed lines on Fig. 1 are the upper and lower inflammability limits of hexane in air.

2. Absorption of the vapor into an oil is useful for reducing the vapor content to lower values than those obtained by cooling or compression. It is more complicated because the oil must be contacted with the gas in a bubble tray or packed absorber and because the oil must be heated and stripped of the solvent by means of steam. If, however, there is available some auxiliary processing operation in which the absorption oil can be stripped or distilled along with other materials, the method of absorption becomes particularly useful. This accounts for the great popularity of absorption in petroleum refining, where frequently the oil is taken from a cracking plant and is returned to the cracking-plant fractionating tower for recovery of absorbed butanes and heavier hydrocarbons. The amount of absorption oil required to recover 95 per cent of the hexane in hexane-air mixtures is indicated in Table 1. The kinds of absorption oils contemplated range from the extreme of a 35° A.P.I. naphthene-base oil of 350° F. mid-boiling point which is very effective, to a somewhat poor absorption oil such as a 44° A.P.I. paraffinic oil of 450° F. mid-boiling point. Additional pressure would be helpful but it was thought that hexane-laden air would ordinarily not be available at a pressure higher than 20 psig.

The above discussion of compression, cooling, and adsorption was included because these operations are so commonplace that little appears about them in the literature.

3. Adsorption of activated carbon is effective on even very low-concentration gases. Most generally it can handle gases down to less than one-third of the lower inflammability limit. The plants are expensive but adsorbers operating on alcohol or ether pay for themselves in less than 6 months.

The operation consists of passing the gas through one of several chambers until the charcoal has saturated itself whereupon rich gas begins to "break" through or pass out of the adsorption chamber. In old natural-gasoline-plant experience, saturation occurs at 10-20 per cent based on the weight of the charcoal. Hexane would probably permit somewhat higher saturations but exact figures cannot be given because each charcoal as well as each hydrocarbon behaves differently. The hexane is removed from the saturated chamber by passing 2-3 lb. of steam per pound of hexane through the chamber. Heat is liberated during the adsorption or condensation and hence water-cooling coils are employed in the chambers. Complete saturation of the charcoal is not attempted in commercial operations because of economic considerations, nor is complete removal of the adsorbed agent attempted. Thus, a cycle of operations is established and automatic controls are universally used to alternate the chambers from saturation to steaming operations. Carbide & Chemicals Corp. has developed an extended type of activated charcoal that reduces the power required to force the gas through the chambers by about 40 per cent compared with the power required for granular-type carbons and it is also said to increase the amount of gas that can be put through the adsorber by about 50 per cent. The development of extruded carbon allowed the application of adsorption to World War II smokeless-powder plants with complete success.

Little specific information can be given because of the differences in hydrocarbons and the different adsorptive powers of carbons. Adsorptive power is a function of the size or opening of the pores in the carbon, and hence special carbons are developed for each different gas that is to be adsorbed. Generally useful information may be had from the following references. A flow diagram for alcohol adsorption plants is given in the somewhat recent Reference

TABLE 1—APPROXIMATE ABSORPTION OIL REQUIREMENTS FOR HEXANE RECOVERY

(Gallons per thousand cubic feet)

No. of plates	At 14.7 psia.			At 20 psig		
	110° F.	90° F.	70° F.	110° F.	90° F.	70° F.
8	37-54	24-35	16-23	16-23	10-15	6.6-9.5
10	32-46	20-30	13-19	14-30	8.7-13	5.7-8.2
12	29-42	18-27	12-17	12-18	7.8-11	5.1-7.4
16	26-37	16-24	11-16	11-16	7-10	4.5-6.6
24	23-34	15-22	10-14	10-14	6.3-9.2	4.1-6.0

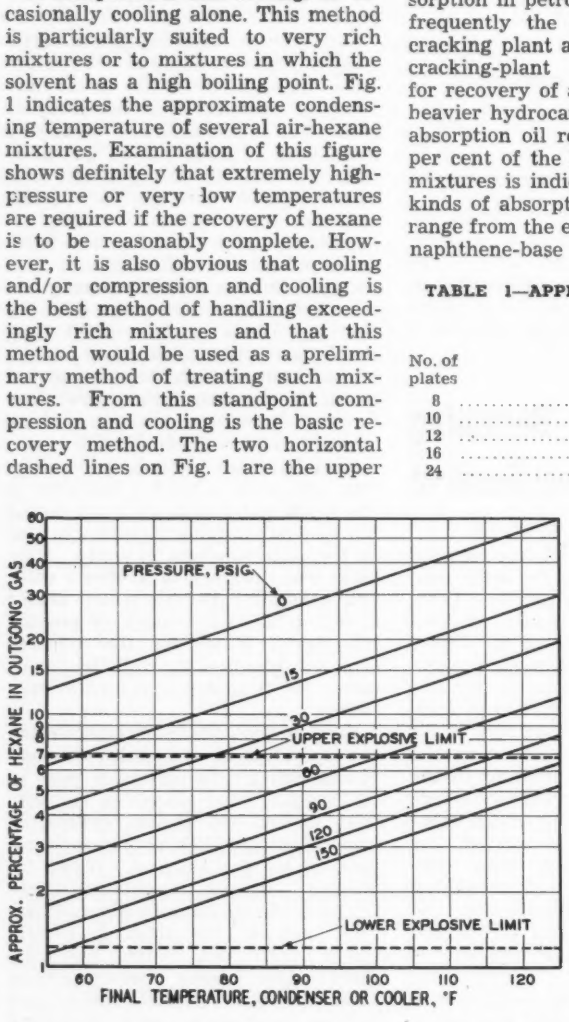


Fig. 1—Hexane left in air-hexane mixture as a function of temperature and pressure, per cent

2. References to the adsorption of hydrocarbons are all old because the process is not used now in natural-gasoline plants.

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Nitrogen Removal From Natural Gas

(Continued from page 79)

liquid is obtained, the air may be fractionated into nitrogen and oxygen streams which leave the plant through the heat exchanger. Methods of fractionation will not be described since this is not important to the refrigeration cycle with which we are concerned here.

It should be pointed out that no removal of heat from the system is effected directly in expanding the high-pressure air through a valve. This type of operation is an adiabatic process without performance of any useful work. The enthalpy or heat content of the high-pressure air entering the valve is, therefore, the same as the enthalpy of the expanded low-pressure air. Heat is, however, removed from the system by the low-pressure effluent gases. This is apparent from Fig. 4B which is a skeleton plot of the temperature-enthalpy diagram for air.

Starting with compressed air from the aftercooler entering the exchanger at point A, it may be seen that the air is cooled at constant pressure to point B, throttled through the expansion valve at constant enthalpy to point C with a drop in temperature, and then heated at constant pressure to point D, the last step representing the path of effluent gas from the plant.

It is necessary in order for heat transfer to take place that the temperature of the gas leaving the heat exchanger (point D) be lower than the temperature of high-pressure air entering the exchanger. However, the enthalpy of the exit gas is higher than the enthalpy of the air entering and the difference in enthalpies represents heat removed from the plant which, at steady-state conditions, must be made equal to the heat leakage into the plant by adjustment of the compressed-air inlet pressure.

An alternate type of internal refrigeration system is utilized in the Linde-Frankl air-separation plants[9]. This system utilizes the heat-removal effect due to expansion of compressed gas through an expansion engine with performance of useful work. The work is useful in the thermodynamic sense and may be either recovered or simply expended in a braking mechanism.

Fig. 5A illustrates the expansion engine refrigeration cycle. In this instance the incoming air need be compressed to only about 85 psig., rather than to 700 psig., as in Joule-Thomson refrigeration cycle. The compressed air is cooled by heat exchange with the nitrogen and oxygen streams leaving the plant and subjected to refrigeration. A stream of nitrogen gas is withdrawn from the fractionation apparatus at 80 psig., and passes through an expansion engine where its pressure is reduced to about 10 psig. Heat is removed from this expanded stream as it does work in the engine and this heat removal furnishes refrigeration to the plant.

The expansion engine refrigeration cycle is illustrated on the skeleton temperature-enthalpy diagram, Fig. 5B. Compressed air entering the heat exchangers at point A is cooled at constant pressure to point B, throttled at constant enthalpy to point C, and then heated at constant pressure to point D, the last step representing the path of gases leaving the plant. However, a portion of the high-pressure stream splits off at point B^1 and passes through the expansion engine emerging at point C^1 to give the refrigeration effect represented by the difference in enthalpies between points B^1 and C^1.

While there is a small Joule-Thomson refrigerating effect between the air entering at 85 psig. and gases leaving at atmospheric pressure, this effect is more than offset by the fact that the gases leaving are at lower temperature than the entering air. The enthalpy of air entering is consequently higher than the enthalpy of gases leaving which represents a heat flow into the plant. The refrigerating effect of the expansion engine must compensate for this heat flow into process as well as the heat leak to the cold apparatus from the atmosphere.

The Joule-Thomson and expansion engine cycles represent internal-refrigeration types in which cooling is obtained through the use of process streams. External refrigeration systems may be set up in which the refrigeration system is entirely independent of the process streams except for the heat exchange between a process stream and the refrigerant. Thus several refrigeration systems may be utilized in series to form a cascade system. Such a series may utilize boiling ammonia liquid to condense ethylene, boiling ethylene liquid to condense methane and boiling methane to condense nitrogen. This system shows power savings over a simple Joule-Thomson refrigeration system for furnishing refrigeration but, due to the different sets of equipment required, material costs are high and simplicity of operation is sacrificed. It is doubtful that a cascade-refrigeration system will show any advantages over an expansion-engine type.

References

List of reference sources will be published for both parts of this article with the second part next week.

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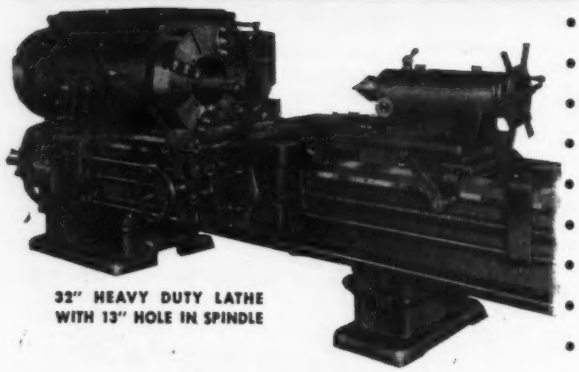

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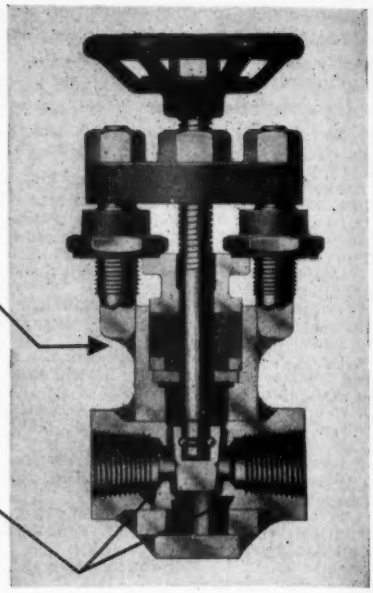

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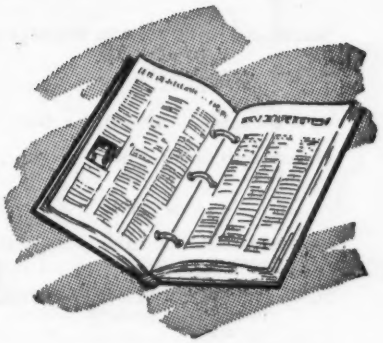
The Refiner's Notebook

A WEEKLY FEATURE OF THE OIL AND GAS JOURNAL



Inspection—Retiring 1½-In. Pipe

PERHAPS the most authoritative standards on pressure piping are those of the American Standards Association. The Code for Pressure Piping A.S.A.-B-31 (1935) specifies four types of service:

Section 1—Power-Plant Piping.

Section 2—Gas and Compressed-Air Systems.

Section 3—Refinery and Gasoline-Plant Piping.

Section 4—Steam Distribution Outside of Power Plant.

Only Section 3 applies directly to petroleum-refinery and natural-gasoline-plant piping.

TABLE 2—PIPING WITHIN REFINERY AND GASOLINE-PLANT LIMITS,* METAL STRESS, PSI.

	W.S. Seamless pipe				W.S. welded pipe	
Temp. (°F.)	Grade A A.S.T.M. 106 A.P.I.-5L	Grade B A.S.T.M.-106	Block B A.P.I.-5L	Grade C A.S.T.M.-106 A.P.I.-5L	Lap A.S.T.M.-53 A.P.I.-5L	Butt A.S.T.M.-53 A.P.I.-5L
500	14,900	19,200	18,600	23,200	11,200	9,300
550	14,400	18,650	18,000	22,500	10,800	9,000
600	13,900	17,950	17,400	21,700	10,450	8,700
650	13,400	17,400	16,800	21,000	10,100	8,400
700	12,700	16,450	15,900	19,900	9,550	7,950
750	12,000	15,500	15,000	18,750	9,000	7,500
800	9,350	12,100	11,700	14,650	.....	.....
850	7,700	9,900	9,600	12,000	.....	.....
900	6,000	7,750	7,500	9,380	.....	.....
950	4,500	5,800	5,620	7,000	.....	.....
1,000	3,000	3,880	3,750	4,700	.....	.....

*Outside refinery limits, strengths that are 2.03 times larger may be used.

TABLE 1—DIMENSIONS OF WELDED AND SEAMLESS STEEL PIPE

Nominal pipe size (in.)	Outside diameter (in.)	Nominal wall thicknesses for schedule numbers									
		10	20	30	40	60	80	100	120	140	160
⅛	0.405	....	....	....	**0.068**	....	**0.095**	....	....	....	....
¼	0.540	....	....	....	**0.088**	....	**0.119**	....	....	....	....
⅜	0.675	....	....	....	**0.091**	....	**0.126**	....	....	....	....
½	0.840	....	....	....	**0.109**	....	**0.147**	....	....	....	0.187
¾	1.050	....	....	....	**0.113**	....	**0.154**	....	....	....	0.218
1	1.315	....	....	....	**0.133**	....	**0.179**	....	....	....	**0.250**
1¼	1.660	....	....	....	**0.140**	....	**0.191**	....	....	....	0.250
1½	1.900	....	....	....	**0.145**	....	**0.200**	....	....	....	0.281
2	2.375	....	....	....	**0.154**	....	**0.218**	....	....	....	0.343
2½	2.875	....	....	....	**0.203**	....	**0.276**	....	....	....	0.375
3	3.5	....	....	....	**0.216**	....	**0.300**	....	....	....	0.437
3½	4.0	....	....	....	**0.226**	....	**0.318**	....	....	....	....
4	4.5	....	....	....	**0.237**	....	**0.337**	....	0.437	....	0.531
5	5.563	....	....	....	**0.258**	....	**0.375**	....	0.500	....	0.625
6	6.625	....	....	....	**0.280**	....	**0.432**	....	0.562	....	0.718
8	8.625	....	0.250	**0.277**	**0.322**	**0.406**	**0.500**	0.593	0.718	0.812	0.906
10	10.75	....	0.250	**0.307**	**0.365**	**0.500**	0.593	0.718	0.843	1.000	1.125
12	12.75	....	0.250	**0.330**	0.406	0.562	0.687	0.843	1.000	1.125	1.312
14 o.d.	14.0	0.250	0.312	0.375	0.437	0.593	0.750	0.937	1.062	1.250	1.406
16 o.d.	16.0	0.250	0.312	0.375	0.500	0.656	0.843	1.031	1.218	1.437	1.562
18 o.d.	18.0	0.250	0.312	0.437	0.562	0.718	0.937	1.156	1.343	1.562	1.750
20 o.d.	20.0	0.250	0.375	0.500	0.593	0.812	1.031	1.250	1.500	1.750	1.937
24 o.d.	24.0	0.250	0.375	0.562	0.687	0.937	1.218	1.500	1.750	2.062	2.312
30 o.d.	30.0	0.312	0.500	0.625	....	....	....	....	....	....	....

All dimensions are given in inches. Thicknesses shown in bold face type in Schedules 30 and 40 are identical with thicknesses for "standard weight" pipe in former lists; those in Schedules 60 and 80 are identical with thicknesses for "extra strong" pipe in former lists. The schedule numbers indicate approximate values of the expression 1,000 × P/S. The decimal thicknesses listed for the respective pipe sizes represent their nominal or average wall dimensions. For tolerances on wall thicknesses, see approximate material specifications.

No. 192 in a series by W. L. Nelson, professor of petroleum refinery engineering, University of Tulsa

BASIS—A.S.A. CODE FOR REFINERY AND GASOLINE-PLANT PIPING—B31 (SECTION 3)—GRADE A SEAMLESS STEEL PIPE (S = 12,000 AT 750° F.)

$$t_m = \frac{PD}{2S} + C$$

t_m = minimum thickness, in.

P = internal minus external pressure, psia.

D = actual outside diameter, in.

S = allowable metal stress, psi. (see tabulation of materials)

C = allowance for threading, welding, mechanical strength and/or corrosion

Values of C

Welding	0.05
Pipe threads	
⅛-in.	0.03
¼-⅜-in.	0.044
½-¾-in.	0.057
1-in.	0.07
2-in. up	0.10

Other materials

Specification	Multiplier
Grade A seamless A.S.T.M.-106, A.P.I.-5L	1.0
Grade B seamless A.S.T.M.-106	.77
Grade B seamless A.P.I.-5L	.80
Grade C seamless A.S.T.M.-106, A.P.I.-5L	.64
Lap welded A.S.T.M.-53, A.P.I.-5L	1.33
Butt welded A.S.T.M.-53, A.P.I.-5L	1.60

Refer to the page ahead for a discussion of the A.S.A. Code for Refinery and Gasoline-Plant Piping, the effect of temperature, etc.

The general relationship between allowable pressure, fiber stress, thickness, and diameter is:

$$t_m = \frac{PD}{2S} + C$$

in which:

t_m = minimum thickness, in.

P = internal pressure, or better, inside less outside pressure, psi.

D = outside diameter, in.

S = allowable fiber stress, psi.

C = allowance for threading, welding, deviations of metal strength and corrosion.

In addition, the Standard Schedule Numbers of Pipe (A.S.A.-B-36.1) includes an extra allowance in the C term for irregularities in thickness, etc., that occur during manufacture. Schedule Numbers are shown in Table 1.

Values of metal stress for refinery and gasoline-plant piping conditions are indicated in Table 2. This table also shows the effect of temperature.

In addition, suggested strengths for certain common alloy steels (based on National Tube Co. "Properties of Steel Pipe and Tubes. . .") are indicated in Table 3.

Little can be said of allowances (C) for corrosion but customary allowances for the depth of pipe threads is indicated in Table 4. The allowance for welding is about 0.05 in. for all Section 3 services and for all sizes of pipe.

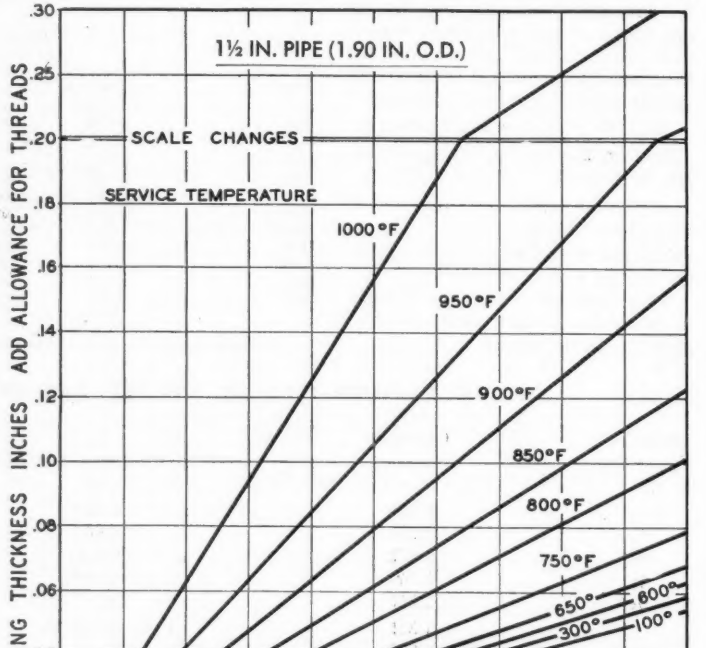


TABLE 3—STRENGTHS (S) OF ALLOY STEELS, PSI.

	Ferritic steels: Carbon moly	Chrome moly	4-6 per cent chrome	Chrome moly	Austenitic 18-8 Cr-Ni
Carbon, per cent	.10-.20	.10-.20	.10-.20	.10-.20	.07
Manganese, per cent	.30-.60	.40-.60	.50	.30-.50	.20-.70
Phosphorus, per cent	.04	.04	.03	.04	.03
Sulfur, per cent	.05	.05	.03	.05	.03
Silicon, per cent	.20-.50	.45-.75	.50	.75-1.25	.75
Nickel, per cent	.....	.....	.....	.....	7-9
Chromium, per cent	.....	1.5-2.0	4.0-6.0	1.0-1.5	17-19
Molybdenum, per cent	.45-.65	.60-.80	.45-.65	.40-.60	.....
Suggested Strengths (S)					
800° F.	15,000	16,500	15,600	17,400	.....
850	12,600	14,100	13,200	15,000	.....
900	10,200	11,500	10,900	12,600	15,000
950	7,600	9,450	8,460	10,000	13,000
1,000	5,100	7,200	6,060	7,800	11,000
1,050	3,400	5,730	4,800	5,850	9,400
1,100	2,050	3,900	3,600	3,900	7,650
1,150	1,500	2,850	2,700	2,850	6,120
1,200	800	1,500	2,000	1,770	4,680

TABLE 4—DEPTH OF CUT IN AMERICAN STANDARD PIPE THREADS

Nominal pipe size	Depth of cut (in.)
⅛-in.	0.0297
¼-⅜-in.	0.044
½-¾-in.	0.057
1-2-in.	0.07
2-in. and up	0.10

NATURAL GAS

Southern Natural Seeks $3,531,600 Expansion

Southern Natural Gas Co., Birmingham, Ala., has asked the Federal Power Commission for authorization to construct and operate additional facilities at an estimated cost of $3,531,600. Such facilities would increase capacity of the company's system by 35,000,000 cu. ft. daily, bringing total capacity to 420,000,000 cu. ft. daily.

Proposed facilities include installation of 10,000 hp. at two compressor stations; about 6½ miles of 24-in. line loops and four 12¾-in. river crossings; a 5,000-hp. compressor station on a supply line between Gwinville gas field and the Pickens station; about 5 miles of 8⅝-in. line looping on the Meridian, Miss., branch line; additional gas-dehydration facilities in Gwinville field, and taps and measuring stations to supply communities in Alabama and Georgia not presently supplied with natural gas. Those communities are: Trussville, Fultondale, Gordo, Pleasant Grove, Graysville, Glencoe, Jasper, Montevallo, and Ashville, Alabama, and Tallapoosa, Ga.

Continental Carbon Bids $1,100,000 for Plant

Continental Carbon Co. has submitted a high bid of $1,100,000 for the government-owned carbon-black plant at Sunray, Tex. Continental is now operating the plant under lease.

The only other bid submitted was $964,000 by Cabot Carbon Co. of Boston. The plant was constructed at a cost of $2,177,000, according to War Assets Administration.

Consolidated Planning Big Expansion Program

Consolidated Natural Gas Co. will spend $60,000,000 or more during 1948 and 1949 for construction of pipe lines, compressor stations, development of wells, and other facilities, according to the company's recently released annual report.

The huge expenditures will be necessary, according to Frank H. Lerch, Jr., president, in spite of the fact that the 1947 construction program was completed practically on time.

Subsidiaries of Consolidated include Hope Natural Gas Co., East Ohio Gas Co., Peoples Natural Gas Co., and River Gas Co. They operate in West Virginia, Pennsylvania, Ohio, and New York.

Texas Eastern Gas Supply to United Cut

Emergency deliveries of natural gas by Texas Eastern Transmission Corp. to United Natural Gas Co. have been ordered terminated by the Federal Power Commission. At the same time Texas Eastern was advised to resume delivery of 10,500,000 cu. ft. of gas daily to Kentucky Natural Gas Corp., while Panhandle Eastern Pipe Line Co. was ordered to make corresponding reductions in its deliveries to Kentucky Natural.

Texas Eastern has been delivering to United Natural since February 12 an additional 10,500,000 cu. ft. of gas daily which would otherwise have been delivered to Kentucky Natural on behalf of Panhandle Eastern.

Panhandle Eastern, through its reduction of gas to Kentucky Natural, will be in a position to increase its gas deliveries to Michigan Gas Storage Co., which has indicated an urgent need of gas for storage through the spring and summer for the 1948-49 winter supply.

Panhandle Sees 10 Per Cent Gain in Capacity

A total increase of 90,000,000 cu. ft. of gas daily in the capacity of Panhandle Eastern Pipe Line Co. is planned by the end of 1949. Of this total 40,000,000 cu. ft. is expected to be available by next February, according to C. H. M. Burnham, vice president and chief engineer of Panhandle Eastern.

The 40,000,000 cu. ft. will represent an increase of a little less than 10 per cent in the pipe-line system's present capacity. Benefit of the expansion plans will be felt in Texas, Oklahoma, Kansas, Missouri, Illinois, Indiana, Ohio, and Michigan, where the company operates.

Burnham said that Panhandle Eastern has been trying to get pipe needed for the construction ever since the program was authorized by the Federal Power Commission in 1946.

The expansion program involves construction of compressor stations and loop lines.

Natural-Gas Sales Well Above Those of 1947

Natural-gas sales of the gas-utility industry during February totaled 2,896,284,000 therms, a gain of 14.1 per cent over the same month of 1947, according to a report of the American Gas Association. (A therm is the heating value contained in about 95 cu. ft. of natural gas.)

For the 12-month period ending February 29 natural gas sales totaled 29,802,960,000 therms, a gain of 12.7 per cent over the previous 12-month period.

The association's index of total sales of natural, manufactured, and mixed gas stood on February 29 at 234.2 per cent of the 1935-39 average.

Natural Gasoline

Warren Lets Contracts For Three 1948 Projects

Three contracts have been let by Warren Petroleum Corp. for construction of natural-gasoline manufacturing facilities in Texas and Oklahoma. The new plants, all contracted by Hudson Engineering Corp., include two absorption plants in Texas—a 30,000-gal. plant at Taylor's Corner and a 20,000-gal. plant at Jacksboro—and a propane manufacturing unit of 20,000 gal. daily capacity at Madill, Okla. All projects are scheduled for completion by January 1, 1949.

A 50,000-gal. absorption plant at Monument, N. M., already under construction by Warren and Dresser Engineering Co., is scheduled for completion September 1. At Holliday, Tex., a second absorption plant with a capacity rating of 20,000 gal. daily and presently under construction by Warren is scheduled for completion in July.

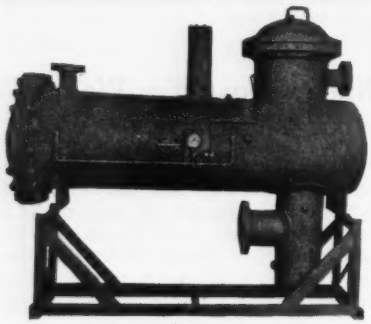
Shell to Add Units to Ventura Gasoline Plant

Additional propane-extraction facilities will be installed in the natural-gasoline plant of Shell Oil Co., Inc., at Ventura, Calif. The new facilities will have a daily capacity of 60,000 gal.

Contract for construction of the facilities has not been let, but completion has been scheduled tentatively for December 1.

The Ventura plant now has a rated capacity of about 175,000 gal. daily.

XUM



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REFINING

Esso Making Progress on Projects at Baton Rouge

Construction activity is continuing in the expansion program in the Baton Rouge refinery of Esso Standard Oil Co., with completion scheduled this spring on a 4,000-bbl. dewaxing unit. Both engineering and construction of the unit are being handled by E. B. Badger & Sons.

Other facilities under construction, scheduled for completion during the third quarter include two vacuum pipe stills of 18,500 and 14,500 bbl. capacity; a light ends recovery unit with a daily capacity of 20,000 M.c.f.; and a 4,000-bbl. polymerization unit. C. F. Braun & Co. has the contract for engineering and construction on the 18,500-bbl. pipe still. On all other projects engineering is being handled by Standard Oil Development Co. and A. G. McKee & Co., with A. G. McKee handling construction.

An 11,000-bbl. light-ends unit is scheduled for completion early in 1949, with E. B. Badger & Sons handling the engineering and construction.

At Esso Standard's Bayway refinery at Linden, N. J., C. F. Braun & Co. currently is erecting a 49,000-bbl. vacuum pipe still and a 41,000-bbl. fluid catalytic cracking and light-ends unit. Completion is scheduled for sometime during the first half of 1949.

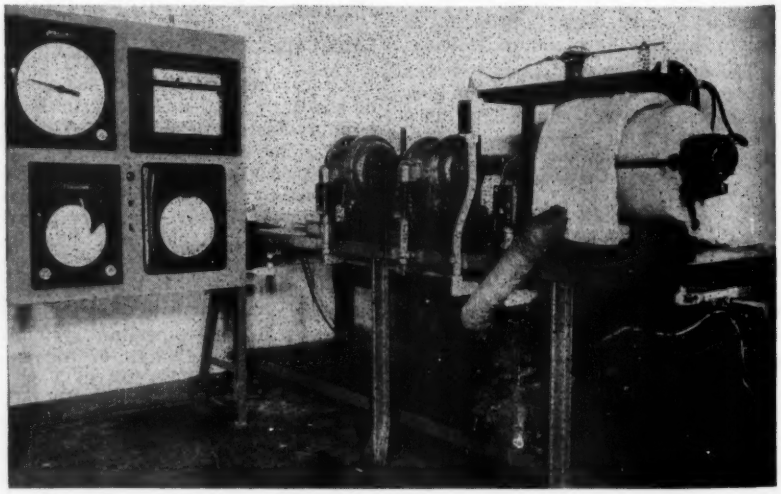
At the company's Charleston, S. C., refinery, Jones & Laughlin Co. on March 1 completed installation of a 6,500-bbl. atmospheric pipe still.

Diesel-Engine Laboratory Allotted Oklahoma A. & M.

Laboratory equipment for diesel engine research from Oberursel, Germany, is being received at Oklahoma A. & M. College, Stillwater, Okla., where the Office of Technical Services, U. S. Department of Commerce, and the U. S. Office of Education have allocated a fully equipped diesel-research laboratory. The laboratory and its equipment were found by Otis D. Treiber, who headed a special investigating team, at the Klockner-Humboldt-Deutz diesel engine plant at Oberursel.

Financial assistance is already assured from the oil industry in the Southwest and this was instrumental in prompting the Government to establish the laboratory in this particular area, according to one Government spokesman. Also, the laboratory will be in an area well separated from present diesel-research laboratories in the eastern part of the United States, a distinct advantage in case of war.

The laboratory consists of three units: a test-cell unit including eight test cells for engines having from one to eight cylinders, a materials testing laboratory, and a fuel-injection labo-



The Texas Co.'s newly developed machine for determining the more important properties of lubricating greases (described in The Oil and Gas Journal, April 1, page 284). On a standard run of 2 hours, the machine shows data on all the more essential properties of a grease and its ability to withstand roller and ball-bearing service

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ratory, plus an oscillograph, X-ray equipment and a Lindner jig borer. As a result of the allocation of the laboratory to the school, the board of regents there has announced that the Oklahoma Institute of Technology will be established by reorganization and expansion of the present division of engineering.

Dubbs Unit in Kansas Ends Run of 164 Days

Recent shutdown of the 4,200-bbl. daily Dubbs cracking unit of Cooperative Refinery Association at Coffeyville, Kans., ended a record run at the refinery.

The unit was on stream 164 days, during which time it processed 720,000 bbl. of charging stock. Louis C. Brown, chief refinery engineer, said the unit could have been operated considerably longer, but its shutdown was ordered to fit into the plant's maintenance schedule.

Brown also said that the catalyst in a U.O.P. catalytic polymerization unit recently was changed after having produced 144 gal. of 10-lb. polymer gasoline per pound of catalyst charged, considerably above the average of about 60 gal.

Sun Awards Contracts At Marcus Hook Plant

Contracts have been let and construction is now under way on Sun Oil Co.'s additions to the MEK dewaxing plant at Marcus Hook, Pa. New facilities will increase the capacity to 2,500 bbl. daily. Process Engineers, Inc., have the contract and completion is scheduled July 1.

Also included in the expansion program are a packaging and compounding plant now under construction by Sun and W. W. Lindsay, contractors, and a wax-refining unit now being installed by Sun at Marcus Hook.

Process Engineers, Inc., recently completed installation of a 2,000-bbl. furfural solvent extraction unit at Marcus Hook.

Southwestern Expansion Contracts Are Awarded

Southwestern Oil & Refining Co., Corpus Christi, has awarded a contract to Process Engineers, Inc., for construction of a catalytic reforming unit with a capacity of 5,000 bbl. daily. Work is expected to begin in time for completion by October.

A catalytic cracking unit and a opping unit also are under contract to Process Engineers with completion date set for early part of 1949. Capacity of the cracking unit is 6,000 bbl. daily and that of the topping unit 25,000 bbl. daily.

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PIPE LINES

Union Electric to Lay 200-Mile Cable Pipe Line

Union Electric Co. of Missouri is contemplating the laying of 22 miles of electric cable pipe line this year which will be the beginning of a 200-mile, 6-in. system to be constructed in a 5-year program to circle St. Louis. However, this will not be a continuous system.

This pipe line will hold electric cable in dielectric oil maintained at 200 psi. Pipe for this purpose is to be laid in a conduit at a depth of 30 in.

In addition to the installations of this type already made in Detroit, New Orleans, San Antonio, and Atlanta, it is reported that construction will be undertaken this year in 10 cities in the United States for such electric cable pipe lines in order to obtain the advantages of reduced liability.

Contract Bids Asked for North Hugoton Gas Line

Contract bids for the construction of the North Hugoton-Kansas City 26-in. line between the compressor-station site at Ulysses and Hutchinson, Kans., and between the Ottawa compressor station and Kansas City, have been requested by Cities Service Gas Co. from 10 contractors. Completion of the project is tentatively set for December 1.

Capacity of the pipe-line system will be increased approximately 90,000,000 cu. ft. daily with the new facilities. Specifications and requests for bids for hauling and stringing the 26-in. pipe have also gone to prospective contractors.

Nisku-Edmonton Line To Be Started Soon

Imperial Pipeline Co., subsidiary of Imperial Oil, Ltd., is scheduled to begin construction soon on a 17-mile, 8-in. crude-oil line from the Nisku railhead to the Imperial Oil refinery now under construction at Edmonton, Alta.

The line would carry oil produced in Leduc field, which is now being piped the 8 miles from Leduc to Nisku and loaded there in tank cars. The line tentatively is scheduled for completion by early September, with the exact date depending upon the availability of pipe.

Imperial also is planning construction of about 12 miles of gathering and lateral lines in Leduc field. The company currently has under construction a 6-mile, 6-in. line to connect the main Leduc line with the new Woodbend field. Completion date on this project has been set as July 1.

The Imperial refinery at Edmonton is being built largely of facilities contained in the Whitehorse refinery purchased from the United States.

Crude-oil lines serving Creole Petroleum Corp. terminal in Western Venezuela. Lines are supported above ground; provision for expansion may be observed at the left

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The Whitehorse refinery currently is being dismantled and moved by trucks and railroad to the Edmonton site. First units are expected to be in operation this summer.

FPC Upholds Decision to Allow Texas Gas Merger

Authorization of Texas Gas Transmission Corp. to acquire by merger and to operate the facilities of Memphis Natural Gas Co. and Kentucky Natural Gas Corp. for the transportation and sale of natural gas has been affirmed by the Federal Power Commission.

(For expansion plans and a map showing the route of a proposed $60,000,000 pipe line connecting Memphis Natural Gas Co.'s and Kentucky Natural Gas Corp.'s facilities, see The Oil and Gas Journal, February 26, page 166.)

Affirmation of the authorization to merge followed a review of the presiding examiner's decision by the commission. According to the examiner the proposed merger would result in a saving of more than $50,000 a year in expenses, that the credit and bargaining positions of the merged company would be improved over those of the three separate companies, that the ability to acquire gas supplies would be increased and that the increasing demands of natural gas customers would be more fully met.

One commissioner dissented.

Conoco Will Build Crude Line Near Wichita Falls

A $150,000 crude-oil pipe line is being planned by Continental Oil Co. whereby crude runs to the company's Wichita Falls, Tex., refinery will be increased more than 6,000 bbl.

The new 6-in. line will run from a point 3 miles east of the refinery, 16 miles eastward to the Ringgold-Joy sector of Clay County. Here the line will connect with the company's 4-in. line to southern Clay County.

Texas Eastern Operates Ten Compressor Stations

Texas Eastern Transmission Corp. is now operating 10 compressor stations on the Big Inch system. These stations include seven equipped with centrifugal compressors at Fordyce, Little Rock, and Egypt, Ark.; Norris City, Ill.; Princeton and Batesville, Ind.; and Lebanon, Ohio, and three stations equipped with reciprocating compressors at Hope, Ark.; Oran, Mo.; and French Lick, Ind. These stations are part of the company's 21-station construction program.

During March gas was transmitted through the system from southwest-

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ern states to the Ohio River valley and western Pennsylvania at an average rate of approximately 300,000,000 cu. ft. daily. Satisfactory results are reported in the operation of centrifugal compressors.

Two Companies Request River Crossing Permits

HOUSTON.—Requests for permission to make pipe-line crossings over navigable streams have been filed with the Army Engineers office in Galveston by Tennessee Gas Transmission Co., Houston, and Texas Pipe Line Co., Houston.

T.G.T. proposes to place a 26-in. gas line under the Trinity River about 7 miles southeast from Goodrich, Polk County, Texas. Texas Pipe Line plans to lay a 20-in. line under Old River about 3 miles northeast from Mont Belvieu, Chambers County, Texas.

Pittsburgh Group Will Lay 242 Miles in 1948

The Pittsburgh Group of companies of Columbia Gas & Electric Corp. is undertaking the construction of 242.4 miles of gas lines in 1948.

Of these projects Williams Brothers Corp. is now in the process of completing the Coatesville, Pa.,-Port Jervis, N. Y., 118-mile, 14-in. line for Manufacturers Light & Heat Co. and the Port Jervis-Deer Park, N. Y., 4.7-mile, 14-in. line for Home Gas Co. In January, Rich & Co. completed laying 1.3 miles of 14-in. for Manufacturers Light & Heat Co. to connect its system with Texas Eastern Corp.'s compressor station at Waynesburg, Pa.

Later this year there is to be laid 119.4 miles of pipe ranging from 4-in. to 14-in. diameter. Included in this program which has been planned are the following projects: 29 miles of 4-in. to 12-in. to be completed in July to serve the Majorsville storage field for Manufacturers Light & Heat Co.; also 26.4 miles of 12-in., Hancock to Cochecton, N. Y., and 25 miles of 10-in., Horseheads to Dundee, N. Y., both for Home Gas Co.

Pipe-Line Revenues in 1947 Show Increase

The combined pipe-line revenues of the 44 crude-oil and products pipe lines reporting to Interstate Commerce Commission, increased 9.8 per cent in 1947 over the revenues of 1946 for this group.

These companies transported 208,000,000 bbl. more in 1947 than they did in 1946. The largest increases in revenue, all amounting to more than 25 per cent, were reported by Kaw Pipe Line Co., Standish Pipe Line Co., and Pan American Pipe Line Co. Losses in revenue were reported by 7 of the 32 crude-oil pipe lines.

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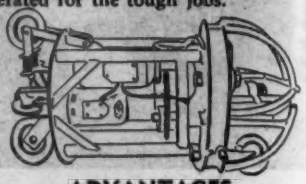

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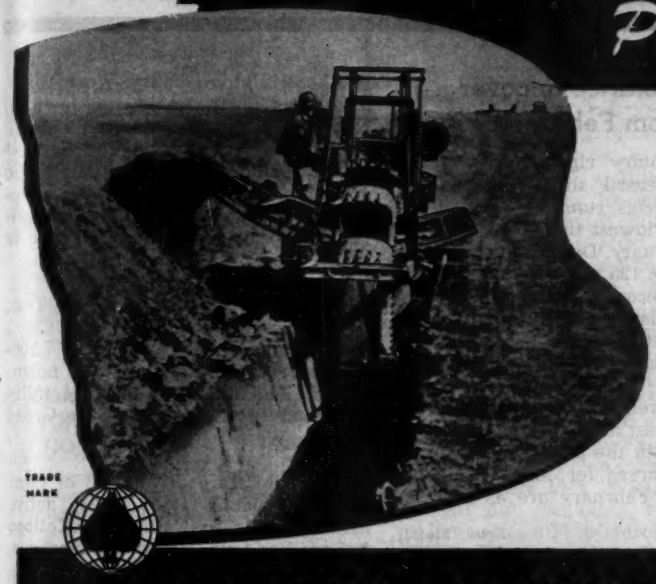

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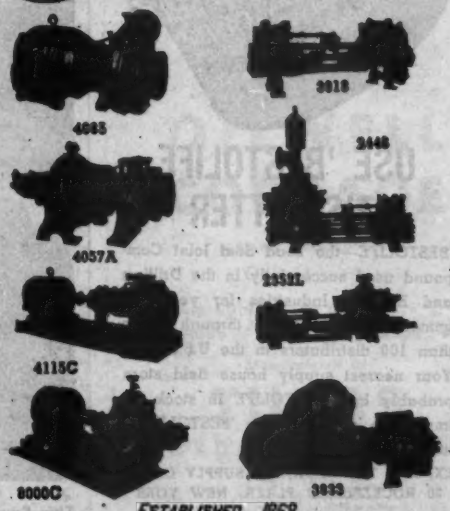

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Among the

Drilling Contractors

Active Rotaries Recover Some From February Low

Active rotary rigs in the United States increased slightly in March, with 1,960 rigs running, after dropping to the lowest figure in 9 months during February. Despite the increase, the figure is 125 rigs short of the all-time high recorded last October.

In these latest figures released by the Interstate Oil Compact Commission, all areas showed a gain except Kansas and West Texas-New Mexico. Largest increase was chalked up by the Gulf Coast area with 36 more rigs active than in the previous month.

Rigs by areas for March as compared with February are as follows:

	Feb.	March
Pacific Coast	157	160
Oklahoma	249	250
Kansas*	110	110
Rocky Mountains (including western Canada)	168	178
N. La., E. Tex., and Ark.	135	144
W. Tex. and N. Mexico	532	530
Gulf Coast	488	524
Illinois	56	64
	1,895	1,960

Noble Drilling Corp., Fort Worth, has moved in rotary tools to drill Samedan Oil Corp. 1 H. F. Neal, in southeast Upton County, West Texas, 1½ miles northeast of the town of Rankin. The 6,500-ft. project is 2,310 ft. from north and west lines of Section 26, Block B. It is said to be on spread of approximately 4,000 acres assembled by Porter Rankin, of Midland, who turned it to Sameden to drill.

Mabee Drilling Co., Midland, Tex., is to drill Cities Service Oil Co. 1 Dr. Edward H. Jones, proposed 7,500-ft. Ellenburger wildcat 4 miles northeast of Knickerbocker and 7¾ miles southeast of Tankersly, Tom Green County, West Texas.

Contractors are drilling 13 of General Petroleum Corp.'s 21 active drilling wells in California. **Kellogg & Sons** has four, **Hayes** and **Sprague, Fowler,** and **Santa Marie** two each, and **Drilling & Exploration, Camay,** and **Southwest,** one each.

Makin Drilling Co., Hobbs, N. M., has all five rigs running at present on contracts for Skelly Oil Co., Tide Water Associated Oil Co., Continental Oil Co., Magnolia Petroleum Co., and N. G. Penrose and Stanolind Oil & Gas Co. Wayne Ballew has recently joined Makin at toolpusher.

This Superior Oil Co. crew is working on the rig which drilled the world's deepest well last year in Caddo County, Oklahoma. Currently, this big steam rig is drilling below 11,750 ft. on a wildcat, the 1 L. McDaniel, located on the outskirts of the town of Lindsay, Garvin County, Oklahoma. Crew members shown are: J. B. Short, driller; F. E. Holmes, derrick man; E. R. Steffey, cathead operator; O. C. Scaggs, fireman; and Nat Atkins, backup man

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RUNNING High

Murfin Drilling Co.
Wichita

Growth.—I. W. Murfin entered the contracting business in 1926, during the El Dorado boom, with two cable-tool rigs. Before starting out on his own, Murfin had worked up from a rig builder's helper to drilling superintendent for Neeley Oil Co. of Wichita. By 1935, Murfin had expanded his 2 rigs to 10 and was taking contracts all over the state of Kansas. In 1942 he went into partnership with R. E. Barber and Cromwell & Lewis to buy a rotary rig and form Threeway Drilling Co., meanwhile continuing to operate his own cable-tool concern. In July 1945 Murfin and Lewis bought out the other two partners of Threeway and in March 1947 added another rotary rig to the company's equipment. Threeway was dissolved August 1, 1947, with Murfin taking one rotary and Lewis the other. In the meantime, Fred and W. R. (Bill), Murfin's two sons, had been released from military service, and I. W. took them into partnership and formed Murfin Drilling Co. Today the concern operates two spudders, five cable-tool rigs, and a 5,000-ft. rotary.

Sidelights.—In his 22 years as a contractor, Murfin has brought in a number of extension and discovery wells. Among these are the discovery wells of Lanterman pool, Barton County, Kansas (1935), and Sullivan pool (now Gorham), Russell County, Kansas (1935), which were both for his own account. He also drilled, under contract, the discovery well of Schurr pool, Rice County, Kansas (1930). . . . The company currently has approximately 7,000 bbl. monthly of crude production. Fred lives in Russell, Kans., and looks after the producing properties while Bill is office manager in Wichita in addition to field duties. . . . Last August a Beechcraft Bonanza was purchased and is flown by Bill who was a Naval aviator in the last war. . . . Present locations of the cable-tool rigs are in Butler, Cowley, and Russell counties, while the rotary rig is active in Ellsworth County.

Frizzell Drilling Co., Oklahoma City, is currently operating two rigs—one in Stephens County, Oklahoma, and the other on a wildcat in North Dakota. Sam B. Raitman has recently become associated with Frizzell.

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Exploration and Drilling

New Pennsylvania Pool for West Texas

A NEW Pennsylvanian pool seems highly probable, if unofficial reports on a Hale County, Texas, wildcat are substantially correct. Moreover, the well is a test which was abandoned in 1941, after being drilled to granite.

In 1941, Humble Oil & Refining Co. et al drilled a well 1,980 ft. from the north and 660 ft. from the east line of Section 17, Block "K," TTRR Survey, Hale County, Texas, about 2 miles northeast of Petersburg. It was abandoned in granite at total depth of 6,756 ft.

A block around this old test was assembled by M. B. Arick of Midland, and he turned part of the spread to General American Oil Co. of Texas. Unconfirmed reports allege that the deal involved 300 acres around the old well, plus 1,500 acres and a half interest in other holdings, in return for an agreement to open the old hole and test it.

General American 1 A. F. Byrd thus became an active operation again. According to reports, a bridging plug was set at 6,021 ft., casing perforated at 5,916-25 ft. with 24 shots, a packer set on drill pipe at 5,900 ft., and swabbing started through the drill pipe. On the second pull of the swab, a 50 per cent oil-50 per cent mud fluid was recovered. After several hours of swabbing, recovery is reported to have been almost 100 per cent oil of 40° gravity.

Crew then started to pull drill pipe, and when 3,800 ft. of pipe had been recovered, well is said to have headed, making some oil and water. After all pipe was pulled, total recovery was 3,200 ft. of oil and 1,200 ft. of salt water.

More testing of various intervals followed, then operator set a bridging plug at 5,910 ft., perforated 5½-in. casing at 5,835-95 ft., set a packer at 5,818 ft., and made a 2-hour drill-stem test. Gas appeared at surface in 6 minutes, volume not estimated. Crew then started to pull drill pipe, and after 4,000 ft. of dry drill pipe had been drawn, well is said to have unloaded and sprayed oil at regular intervals during the pulling of remainder of pipe. The last 1,500 ft. of pipe was, according to reports, full of 40°-gravity oil.

Then the well was washed with 500 gal. of mud acid, and given a 1,000-gal. regular acid treatment, followed by swabbing. An 8-hour swabbing test was reported to have averaged 8 bbl. per hour of oil. Then a 6,000-gal. acid treatment was injected through the perforations and the well swabbed. It is said the well kicked off and flowed 37 bbl. the first hour, 40 bbl. the second, and 52 bbl. the third hour.

Still later reports were to the effect that after 72 hours of continuous swabbing, the well was swabbing 11 bbl. of oil per hour with a slight cut of water.

Formation top reported is Cisco at 5,810 ft., and the pay zone is called Cisco by some, considered upper Canyon by others. The new test is 7½ miles east of the discovery well and lone producer in Petersburg pool, which is producing from the Cisco.

HIGHLIGHTS OF WEEK'S DEVELOPMENTS

ROCKY MOUNTAIN.—Two new pay discoveries increased activities in central Wyoming: Ohio Oil Co.'s deep Medicine Bow test, Carbon County, flowed 50 bbl. of oil hourly on drill-stem test, and Sinclair Wyoming Oil Co. 2 Wertz "D" found oil in the Madison at Wertz field, Sweetwater County. There was no Newcastle sand in South Beaver Creek Syndicate's wildcat between Mush Creek and Ant Hills fields in Weston County, but the well is being drilled deeper, possibly to the Minnelusa. Shows of oil were encountered in the Hygiene formation at the Suhr et al wildcat east of Denver, Adams County, Colorado, but test showed only mud.

CANADA.—Leduc field's production has been extended 1½ miles southward by Okalta-Leduc 2, LSD 10, 33-49-26w4. Globe-Leduc 7, LSD 5, 19-50-26w4, 2½ miles west of the proven field, recovered oil on drill-stem test around 5,200 ft., and is preparing for production test.

TEXAS GULF COAST.—Sunray Oil Corp. opened a new field in Goliad County with the 1 Fannie Marshall, gas-condensate producer 6½ miles north-northwest of Goliad.

MICHIGAN.—Swan-King brings in its third producer, the 1 Paterek, to pace the rapid development of the new pool in Pinconning Township, Bay County.

NORTH LOUISIANA.—Halbouty and Stanolind Oil & Gas Co. 1 Bolinger-Boyd, wildcat east of Plain Dealing field, 30-23n-12w, Bossier Parish, is drilling ahead below 5,950 ft. after recovering salt water on drill-stem test at 5,630-46 ft.

MID-CONTINENT.—In Garvin County, Oklahoma, Sohio Petroleum Co. may prove a new pay zone at the offset to the Eola pool opener. Tests at the 1 Dunlap, 17-1n-2w, recovered oil and water load some 600 ft. below the producing horizon of the discovery well. In Kansas, Stanolind Oil & Gas Co. 1 Wheatley, 15 miles east of the Hugoton gas field in Seward County, pumped 48 bbl. of oil from the Marmaton at 5,095-5,100 ft.

SOUTH LOUISIANA.—Roeser & Pendleton et al 1 Lutcher-Moore Lumber Co., 14-6s-13w, opened a new pay in Bancroft field of Beauregard Parish. The California Co. has made locations for two deep tests on state leases in the Gulf of Mexico.

SOUTHWEST TEXAS

New Oil Pay Opened in South Longhorn Field

CORPUS CHRISTI.—A new oil pay for South Longhorn field, Duval County, has been opened by Hiawatha Oil & Gas Co. A-4 Leroy Denman, in Santos Garcia Grant, 4¼ miles east of Realitos. Top of pay is 4,180 ft., with perforations for completion at 4,186-90 ft. On potential test the well flowed 58 bbl. oil per day through a 7/64-in. choke, with gas-oil ratio 1,113, gravity 24°, with no water in the flow. Total depth is 5,804 ft.

In McMullen County, Edwin M. Jones estate C-5 Harry Ezzell, agent, opened a new gas pay in San Caja pool, Section 56, Hays-Ezzell Subdivision, 14 miles southwest of Simmons City. This is an old well drilled deeper with old total depth 7,488 ft. Operators drilled to new total depth of 7,488 ft. and opened new sand at 8,250-97 ft. Initial production flowed 1,000,000 cu. ft. of gas per day through a ¼-in. choke, tubing pressure 500 psi., no water.

A new pay for Los Indios pool in Hidalgo County was brought into production at Baldridge & King et al 10 W. L. Goldston, in Santa Anita Grant, top of pay "J" sand, at 6,486 ft. Drilled to a total depth of 7,252 ft., this well flowed 2,800,000 cu. ft. gas per day on open flow, through perforations at 6,486-6,511 ft.

Anderson & Prichard Oil Corp. 1 S. E. McKnight, 3 miles west of Carrizo Springs, in Dimmit County, flowed dry gas with 170 psi. working pressure in 20 minutes on drill-stem test at 2,190-2,209 ft., using ¼-in. and ½-in. chokes, with bottom-hole pressure of 1,075 psi. flowing and 1,100 psi. shut in.

Rock Hill Oil Co. and W. Earl Rowe 2 Elmer D. Wood et al, wildcat test in northern Nueces County, 5½ miles north-northwest of Robstown and 2 miles east of the East Riverside field, developed 286 psi. working pressure in 15 minutes and recovered 700 ft. of oil in drill-stem test at 7,237-44 ft., using ¼-in. chokes. Operators cored 5 ft. deeper and ran new test at 7,240-49 ft., results not reported as yet.

Ryan, Hays & Burke and Daubert & Achning 1 N. Saenz, located 6,400 ft. north of the discovery well at San Pablo field, in Jim Wells County, gaged 76 bbl. of oil per day day through a ½-in. choke, with 625 psi. tubing pressure on initial test. The well later died, but swabbed in again and flowed 7 bbl. of oil per hour through a 7/32-in. choke. Operators are now testing on various chokes. Oil was logged at 2,836-49 ft. Located in El Sordo Grant, 14 miles southwest of Hebbronville.

The 48 new locations reported this week included 23 wildcat starts, 4 in Duval, 3 each in Edwards, Nueces and Zapata, and 1 each in Atascosa, Bastrop, Bexar, Brooks, Caldwell, Frio, Guadalupe, Starr, Webb and Williamson counties. Three successful exploratory wells were completed to open oil pay in Duval County, and one gas pay each in Hidalgo and McMullen counties. Thirteen wildcats were dry, three in Zapata, two in Jim Hogg, and one each in Duval, Edwards, Frio, Jim Wells, McMullen, Nueces, Webb and Williamson counties.

SOUTHWEST TEXAS (DISTRICTS 1 & 4) SUCCESSFUL WILDCATS

Duval County: New oil pay South Longhorn field—Hiawatha Oil & Gas Co. A-4 Leroy Denman, in Santos Garcia Grant, 4¼ mi. E of Realitos, top pay 4,180 ft., TD 5,804 ft., perf. 4,186-90 ft., IP: 58 bbl. oil per day through 7/64-in. choke, GOR 1,113, TP 530 psi., CP 890 psi., gravity 24°, no water.

Hidalgo County: New gas pay Los Indios pool—Baldridge & King et al 10 W. L. Goldston, in Santa Anita Grant, top pay 6,486 ft. "J" sand, TD 7,252 ft., perf. 6,486-6,511 ft., IP: 2,800,000 cu. ft. gas per day on open flow, shut-in pressure 2,582 psi., no water.

McMullen County: New gas pay San Caja pool—Edwin M. Jones Est. C-5 Harry Ezzell, Agt., Section 56, Hays-Ezzell Subd., 14 mi. SW of Simmons City, near Live Oak County line, old well drilled deeper, old TD 7,488 ft., new TD 9,130 ft., top pay 8,250 ft., perf. 8,250-97 ft., IP: 1,000,000 cu. ft. gas per day through a ¼-in. choke, TP 500 psi., no water.

SOUTHWEST TEXAS (DISTRICTS 1 & 4) WILDCAT FAILURES

Duval County: Caroline Hunt Trust Est. 1 Ernest Miller, in Block 32, King & Hillje Subd. of Diego Hinojosa Sur., 5½ mi. SW of Realitos, dry, TD 5,007 ft.

Edwards County: Louis E. Smith et al 1 Mrs. Myra Wardlaw, in Section 80, GC&SF Sur., Block F, 30 mi. SW of Rock Springs, near Wardlay field, dry, TD 400 ft.

Frio County: Kirkwood and Morgan 1 Roberts & Speer, in R. M. Harkness Sur., 10 mi. W of Dilley, dry, TD 5,750 ft.

Jim Hogg County: Baldridge & King et al 4 Mrs. Sarita K. East, AB&M Sur. 37, 16 mi. SW from Hebbronville, 7½ mi. S of Armstrong field, dry, TD 3,926 ft.

Sun Oil Co. 1 E. L. Armstrong Est., H. C. Yeager Sur. 295, 10 mi. SW of Hebbronville, in Armstrong area, dry, TD 3,712 ft.

Jim Wells County: Sunray Oil Corp. 1-E C. T. Hewitt, Sec. 44, R. P. Haldeman Subd. of Seeligson Ranch, 3 mi. NW of Premont townsite and 1 mi. S SW of South Haldeman field, dry, TD 6,252 ft.

McMullen County: Gulf Oil Corp. 1-D Shiner Est., in Jose Aldrete Grant 14, 5 mi. SW of San Caja field, 8 mi. N of Brazil, dry, TD 9,500 ft.

Nueces County: Rock Hill Oil Co. and Geo. B. Buescher 1-A Johanna Wm. Mann, in F. Z. Bishop Subd. of Weil ranch, 4 mi. W of Bishop, dry, TD 8,012 ft.

Webb County: Harry E. Murray 1-A Mabel Adami, in Sur. 337, 1 mi. S of Adami field, dry, TD 1,108 ft.

Williamson County: A. J. Maresh 1 Albert Pfueger, in Hamilton White Sur. 3, 7 mi. SE of Taylor townsite, dry, TD 1,010 ft.

Zapata County: American Republics Corp. 1 Aureliano Uribe, in Jose Vanquez Grant, 18½ mi. NE of Zapata, in Trinidad area, dry, TD 6,127 ft.

Green Valley Drlg. & Supply Co. 1-A E. A. Bowles, in Charco Redondo Grant, dry, TD 1,965 ft.

Green Valley Drlg. Co. 1 Maria Garcia et al, Share A, Charco Redondo Grant, 1½ mi. W of Charco Redondo field, dry, TD 845 ft.

SOUTH LOUISIANA

New Producing Sand Opened in Bancroft

NEW ORLEANS.—A new oil-producing sand has been opened in Bancroft field of Beauregard Parish by Roeser & Pendleton, Inc. et al 1 Lutcher-Moore Lumber Co., SE NW of Section 14-6s-13w. Drilled to a total depth of 8,392 ft., with 5½-in. casing set at 8,100 ft., this well flowed on potential test 134.8 bbl. of oil per day through a ½-in. choke, with 850 psi. flowing pressure on the tubing and a gas-oil ratio of 1,014. The oil is 43.9° gravity, and production is through perforations at 7,744-46 ft.

The California Co. has located two 12,500-ft. wildcat explorations on state leases in the Gulf of Mexico, Plaquemines Parish area. The 1 State Lease 1,278 is in the North Pass area and is 6 miles east of production in Delta Duck field, being 15 miles southeast of Barnsdall et al new discovery just off the north side of Breton Island in Breton Sound. The other wildcat is 1 State Lease 816 in the West Delta area, 6 miles west-southwest of Venice field production and is 1¾ miles offshore.

The Texas Co. 89 State Lease 188, in Caillou Island field, Terrebonne Parish, has been completed for an initial production of 503 bbl. of oil per day through 10/64-in. choke, gas-oil ratio 966, 36°-gravity oil. Total depth is 11,524 ft., with production from sand perforated at 11,148-173 ft.

In Iowa field, Jefferson Davis Parish, Shell Oil Co., Inc., 10 A. O. Fontenot, 7-9s-6w, was completed at a total depth of 9,537 ft., for a potential gage of 217 bbl. of 45°-gravity oil per day through a 9/64-in.

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choke, gas-oil ratio 25,207. Production is through perforations at 9,454-62 ft. and 9,426-36 ft. with top of sand at 9,426 ft.

There were 24 new locations reported this week, 8 of which are wildcat starts, 2 in Plaquemines and 1 each in Acadia, Iberia, Lafourche, St. Martin, St. Mary and Terrebonne parishes. One successful exploratory test opened a new oil sand in Bancroft field of Beauregard Parish while one wildcat was dry in Avoyelles Parish. Five oil wells were completed in proven areas.

SOUTH LOUISIANA SUCCESSFUL WILDCAT

Beauregard Parish: New oil sand Bancroft pool—Roeser & Pendleton, Inc., et al 1 Lutcher-Moore Lumber Co., SE NW 14-6s-13w, TD 8,392 ft., top sand 7,744 ft., perf. 7,744-46 ft., IP: 134 bbl. oil per day through a ⅛-in. choke, GOR 1,014, TP 850 psi., 43.9° gravity, 0.1 per cent water.

SOUTH LOUISIANA WILDCAT FAILURE

Avoyelles Parish: H. L. Hunt 1 J. A. Airey et al, Sec. 1-1s-3e, in Lake Pearl, dry, TD 8,525 ft.

MICHIGAN

Narrow Pool in Bay County Extended a Mile

SAGINAW.—Swan-King Oil Co. 1 Paterek offset to the December discovery in Pinconning Township, Bay County, was rated at a daily potential of 1,600 bbl. after acidizing. Production is from the Dundee at 2,830 ft., somewhat higher than the discovery and the southwest offset and proving the narrow pool for a northeast-southwest range of slightly more than a mile. Swan-King is drilling two other wells, preparing two more.

Michigan field operations for the week resulted in eight completions, including the Paterek, and five wildcats, four of which were dry holes. The fifth is a small gasser in Casnovia Township, Muskegon County. Small wells, each pumping 12 bbl. a day were completed in Arbela field in Tuscola County and in Geneva Township, Van Buren County.

A ninth operation, deepening of a 1945 gas-well completion in Richland Township, Montcalm County, was dry and abandoned at 3,472 ft. in the Dundee.

Seven new locations were announced, one each in Allegan, Kalakaska, Ogemaw, Oceana and Midland counties, two in Crawford County. Pure Oil Co. is drilling the Midland location in Greendale Township, and one of the two Beaver Creek Township wells in Crawford County, its third in Lincoln of Osceola. Sun Oil Co. has the other.

MICHIGAN SUCCESSFUL WILDCAT

Muskegon County, Casnovia Township: Rex Oil & Gas Co. 1 Dewey Todd, SW SW NW 26-10n-13w, gas well, 139,000 cu. ft., TD 2,293 ft.

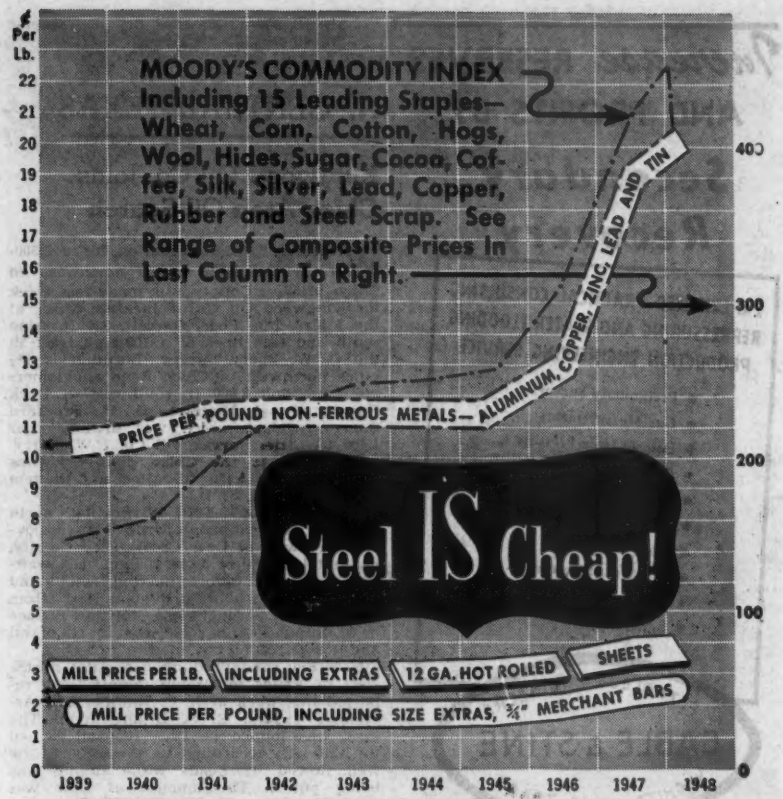
MICHIGAN WILDCAT FAILURES

Allegan County, Heath Township: Augie Busk 1 Edward Erwin et al, SE NE NW 35-3n-14w, dry in Traverse limestone, TD 1,475 ft.

Bay County, Pinconning Township: McClanahan Oil Co. 1 Otto Fanger, NE NW NW 32-17n-4e, dry in Dundee, TD 3,268 ft.

Barry County, Hope Township: R. B. Tamblyn Development Co. 1 Robert O. Zielinski, SE SE SW 29-2n-9w, dry in Traverse limestone, TD 1,851 ft.

Lake County, Cherry Valley Township: H. E. Walton 1 Angelo Garidello Estate,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Sheets and merchant bars are two finished steel items in most popular demand. They comprise nearly 22% of all mill shipments of finished steel in 1947.

Now, compare prices on steel's most wanted items with composite prices on the five non-ferrous metals. In 1939 it was over 10 1/2¢ per lb. By 1948 it had zoomed to over 20¢ per lb. Or, compare the steel industry's record of holding prices down with prices on the 15 leading commodities which affect the cost of living most. Composite prices of these shot up from an index of 150 in 1939 to over 450 as of January 1948.

Had steel prices made comparable advances to non-ferrous metals, the price on sheets and bars would now be 4 1/2¢ per lb. or 7 3/4¢ per lb. had steel prices advanced like commodity prices.

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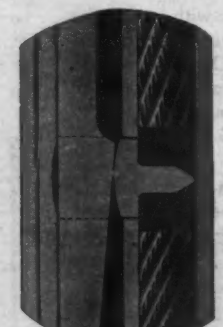

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SE SE SW 13-18n-12w; dry in Traverse limestone; TD 2,965 ft.

N. CENTRAL TEXAS

Kingwood Oil Co. Joins Chico Area Oil Search

WICHITA FALLS.—Location for a 5,500-ft. wildcat 4½ miles northwest of Chico in Wise County was made last week for Kingwood Oil Co of Jackson, Miss., at the 1 Mrs. Ima Pearl Garrett, 330 ft. from south and east lines of a 100-acre tract in the C. W. Egery Survey. Location is 1½ miles northwest of Chico Bend conglomerate field, and 8,000 ft. southwest of Burk Royalty Co. 1 Maguire, H. H. Bradford Survey wildcat which was drilling near 4,400 ft. Cities Service Oil Co. 1 W. Berry, west offset to the Chico discovery, was drilling below 5,450 ft., after a drill-stem test failed at 5,268 ft.

S. D. Johnson's 2 C. W. Scaling, north offset to the company's Ordovician discovery northwest of Deer Creek, Clay County, had total depth at 5,848 ft. and was waiting on casing before making completion attempts. A 1-hour drill-stem test from 5,775-5,825 ft. brought gas to the surface in 11 minutes, and recovered 20 ft. of oil and 150 ft. of oil-cut mud.

New Fry sand production 4 miles northwest of Bangs in Brown County, was reported this week at L. C. Riordan and Associates 1 Mrs. E. S. Briant heirs. The sand was topped at 1,205 ft., and drilled to 1,218 ft. According to the report, the well flowed by heads while tubing was being pulled. The amount of flow was not estimated.

In Montague County, 4 miles north of Bowie, The Texas Co. and Continental Oil Co. 1 T. H. Bates flowed 102 bbl. of oil, with no water, through ½-in. choke in 4 hours, from the Bend conglomerate at 6,323-45 ft. A second test, through 14/64-in. choke, flowed approximately 11 bbl. of oil in 3 hours. Operators continued testing.

NORTH CENTRAL TEXAS (DISTRICTS 7-B & 9) SUCCESSFUL WILDCAT

Taylor County: Geochemical Survey Co. et al 1 T. J. Bird, Blk. 22, Grimes CSL, League 147, 1 mi. E Merkel, flowed 228 bbl. 42°-gravity oil in 6 hours, ½-in. choke, casing pressure 35 psi., tubing 90 psi., GOR 136 cu. ft., Dotham sand 2,139-2,234 ft., TD.

NORTH CENTRAL TEXAS (DISTRICTS 7-B & 9) WILDCAT FAILURES

Archer County: W. G. Gouchie 1 H. Conrady, Lot 23, Blk. 4, C&P Subd., 2½ mi. W Windshorst, dry, TD in sand 1,145 ft.

Baylor County: Kadane & Sons 1-A R. Q. Quzenberry, Sec. 95, P. L. Leaman Sur., A-264, 2 mi. SE Rendham, dry, TD 5,158 ft., Canyon Reef 3,133 ft., good porosity, show oil, pumped 10 bbl. oil a day, 20 bbl. salt water.

Callahan County: S. C. Herring et al 1 May Humphrey, Anthony Bates Sur. 9, NW corner of county, dry, TD 3,365 ft. in limestone.

Coleman County: Clark & Cowden Drilling Corp. 1 S. F. Weaver, Blk. 20, Lewis Johnson Sur., dry, TD 1,902 ft., slight show of oil 1,802-25 ft.

Cooke County: Fleet Drilling Co. et al 1 W. H. Campbell, Blk. 5, P. F. Leverett Sur., 2 mi. N Myra, dry, TD 1,661 ft., Ellenburger 1,623 ft.

Republic Natural Gas Co. 1 J. B. Pace, J. E. Gilliam Sur., A-1,486, 5 mi. E Marysville, dry, TD 4,326 ft. in limestone.

J. F. Richardson et al 1 E. A. Stanley, J. W. Faucett Sur., 6 mi. NE Gainesville, dry, TD 5,274 ft., recovered dead oil 4,958-66 ft.

W. O. Russell et al 1 R. M. Felty, G. Steele Sur., 1½ mi. NW Hood, dry, TD 1,913 ft., Ellenburger 1,860 ft.

Eastland County: Dixieland Petroleum Corp. 1 J. T. Poe, Sec. 15, Blk. 3, H&TC Sur., 6 mi. SW Carbon, dry, TD 1,335 ft. in shale.

Hardeman County: R. H. Alexander 1 W. F. Williams, Sec. 307, W&NW Sur., 12 mi. N Goodlett, dry, TD 905 ft. in shale.

R. H. Alexander 1 M. S. Winbury, Sec. D, Wheeler CSL, 11 mi. N Goodlett, dry, TD 852 ft. in shale.

Jones County: Ralph R. Carroll 1 Joe A. Rogers, Blk. 2, Goliad CSL, League 358, 7 mi. S Hamlin, dry, TD 3,275 ft.; Noodle Creek 2,585 ft., Saddle Creek 2,800 ft., Flippen 2,852 ft., Swastika sand 3,275 ft., elev. 1,803 ft.

Montague County: Reese B. Price et al 1 Roxie Howard, Blk. 90, Kaufman CSL, 5 mi. N Bonita, dry, TD 2,408 ft. in shale and sand.

Wichita County: Continental Oil Co. and Phillips Petroleum Co. 1 R. L. Jackson, Sec. 16, Tarrant CSL, A-282, 1½ mi. E Iowa Park, dry, TD 5,424 ft., Ellenburger 5,066 ft., oil odor 5,090-5,110 ft., DST recovered oil and gas-cut mud, elev. 1,026 ft.

Young County: A. R. Thompson et al 1 F. P. Johns, A. J. Hitchcock Sur., A-128, 3 mi. NW Graham, dry, TD 4,160 ft., Caddo 3,885 ft., show gas 3,970-75 ft.

MISSISSIPPI

Good Show for Phillips Well in Adams County

JACKSON.—Phillips Petroleum Co. 3 Mrs. Vic Artman, west offset to the discovery well of Pine Ridge field, Adams County, cored 15 ft. of saturated sand from 5,616 ft. to oil-water contact at 5,631 ft. Total depth is 5,710 ft., with 5½-in. casing cemented at 5,695 ft. Casing was perforated from 5,616-24 ft., and production packer

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was run on 2-in. tubing for production test, without squeezing. The well had good pressure and kicked off without being swabbed, cleaned into pit and flowed into tanks several hours before there was any trace of water whatsoever. At latest report well was making 2 per cent basic sediment and salt water.

In Stone County, George Vasen 1 fee, wildcat in Section 9-2s-11w, moved casing on location. Test is bottomed at 14,038 ft., with reported shows at 13,220 ft.

In Lincoln County, Humble Oil & Refining Co. 1 Willard Nations, wildcat, Section 20-7n-9e, is drilling below 9,525 ft.

Texas-Pacific Coal & Oil Co. 1 W. T. Fauver, wildcat in Lincoln County, Section 1-6n-6e, is drilling below 8,060 ft.

One wildcat location in Adams County and eight development starts were reported, four in Baxterville field, Lamar County, and one each in Heidelberg West, Jasper County; La Grange field, Adams County; Mallalieu field, Lincoln County, and Yellow Creek field, Wayne County. Four oil wells and one dry hole were completed this week, all in proven areas.

ALABAMA WILDCAT FAILURES

Baldwin County: Harold K. Boysen & J. Ray Stebbins 1 P. L. Wilson, C SE/4 36-2n-3e, dry, TD 6,817 ft. Tops: Chalk 3,834 ft., First Eutaw sand 5,180 ft., Tuscaloosa 5,525 ft., Lower Cretaceous 6,655 ft.

Escambia County: W. H. Cordell 1 Ed Leigh McMillan, Tr., SW SW 18-3n-10e, dry, TD 5,807 ft. Tops: Midway 2,224 ft., Chalk 2,810 ft., First Eutaw sand 4,224 ft., Tuscaloosa 4,516 ft., Marine Tuscaloosa 5,058 ft., base Marine Tuscaloosa 5,262 ft., Massive sand 5,425 ft., Lower Cretaceous 5,712 ft.

EASTERN TEXAS

San Augustine Gets Promise of Extension

DALLAS.—Hiawatha Oil & Gas Co. 1 Will E. Johnson, southwest outpost test in the San Augustine field, had prospects of production on a drill-stem test between 6,019-6,103 ft. With the tool open 48 minutes, it produced a slight blow at the surface and recovered 55 ft. of mud and oil.

In Smith County, W. F. Nenney 1 Ione Braziel, Thomas Rives Survey, was drilling below 6,537 ft. in shale and lime. Sample tops released by Trowbridge were: Comanchean lime 5,970-80 ft.

Humble Oil & Refining Co. 1 R. P. McWatters, Cotton Valley test in Freestone County, had progressed below 11,692 ft. in shale with streaks of sand, at last report. Humble 1 B. C. Whatley, Freestone County, was below 6,959 ft.

In Henderson County, W. B. Hinton (formerly reported as E. L. Howard), 1 J. M. Criswell, C. M. Walters Survey, was drilling below 2,644 ft. Planned depth is first porosity in the Travis Peak, or to 8,700 ft.

In Kaufman County, 4 miles east of Kemp, T. D. Humphries 1 E. B. Tuggle, Ed Fitzgerald Survey, was reported as a new Paluxy test. Surface casing has been set to 194 ft. and operators were drilling ahead.

Locations for four wildcats and seven field wells were made this week. Wood County gained two exploratory tests by Humble Oil & Refining Co., both being approximately 3½ miles southeast of Yantis, in the Yantis field area. Seaboard Oil Co. of Delaware will drill 1 J. E. Green as a 7,000-ft. test 5 miles southwest of Kosse in Falls County. In Anderson County, Canley Oil Co. 3 Davey & Royall, will be retested and deepened. Location is in Camp Hill field, 10 miles southeast of Palestine. Field locations were: Marion and Panola counties, two each; Henderson, Shelby, and Van Zandt, one location each. Week's completions totaled 15, being 6 oil wells, 1 gas and

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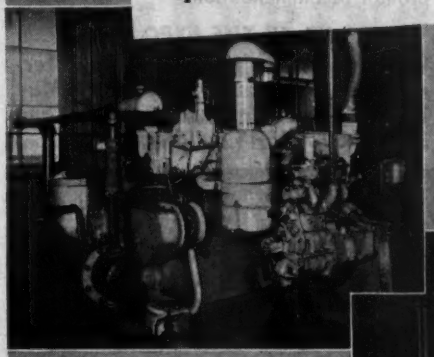
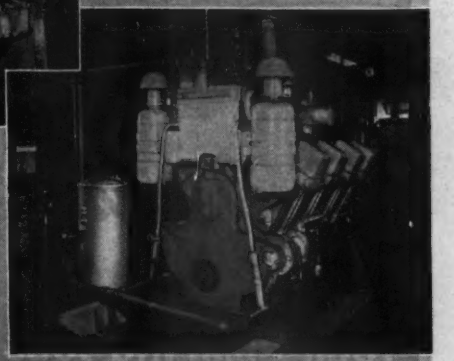


This D17000 Caterpillar operated 13,074 continuous hours without an oil change. Practically no maintenance and engine ran at high rate of efficiency.



This D13000 Caterpillar operated 10,778 continuous hours without an oil change and without a stop for repairs.

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8 dry. Wildcats accounted for four of the failures.

EAST TEXAS (DISTRICTS 5 & 6) WILDCAT FAILURES

Kaufman County: Shell Oil Co., Inc., 1 F. E. Lumpkin, B. S. Newman Sur., 4 mi. SW Cedarvale, dry, TD 10,800 ft., Pecan 1,768 ft., Austin 2,479 ft., Woodbine 3,535 ft., Georgetown 4,348 ft., elev. 435 ft., sample tops: Comanche 4,240 ft., Georgetown 4,248 ft., Paluxy 5,355 ft., Glen Rose 5,654 ft., Massive anhydrite, 6,572 ft., Travis Peak 7,100 ft., Cotton Valley 7,695 ft., Buckner 9,847 ft., Smackover 10,495 ft.

Robertson County: C. W. Herod et al 1 Mary Ferguson, Marino Grande Grant el al Sur., 2 mi. S New Baden, dry, TD 2,760 ft.

Sabine County: Hiawatha Oil & Gas Co. 1 Eidom, J. I. Pefermo Sur., 1½ mi. W Geneva, dry, TD 8,640 ft., Midway 2,606 ft., Arkadelphia 3,458 ft., Georgetown 5,000 ft., Paluxy 5,350 ft., James 7,760 ft., Pettit 8,480 ft., elev. 327 ft.

Upshur County: General American Oil Co. 1 G. L. Hart, Wm. Berryhill Sur., 10 mi. N Gilmer, dry, TD 4,485 ft., Woodbine 4,135 ft., elev. 347 ft.

APPALACHIAN FIELD

Deep Test Located for Derry Township Tract

PITTSBURGH.—On the Fayette anticline in Derry Township, Westmoreland County, Pennsylvania, Peoples Natural Gas Co. has made a location for a deep test on the Camilla Giffin tract which, located on the New Florence Quad, is 1,400 ft. northwest of the first deep test on that tract. This will be the fourth attempt on the closure, none of which showed any production and the Oriskany, where reached, was tightly calcited.

In Wayne Township, Erie County, Pennsylvania Gas Co. logged the Newburg horizon in 2 C. J. Follette at 4,129 ft., and at 4,133 ft. there was about 35 gal. of salt water a day. It is now drilling at 4,182 ft.

New locations totaled four and all in Armstrong County and Cowanshannock, Madison, Mahoning and Kittanning townships.

In Cologne district, Mason County, West Virginia, Columbian Carbon Co. has made a location for another wildcat which, starting at an elevation of 883 ft. on the Gilbert J. Thornton farm, is found on the Belleville Quad 5.27 miles south 38 degrees 55 minutes and 4.28 miles west 81 degrees 55 minutes.

In Lincoln district, Wayne County, E. C. Ware, drilling 2 Johnson, topped the Maxton sand with a showing of about 15 bailers of oil a day at 1,539 ft.

Several good gas wells were completed during the week. In Lincoln district, Wayne County, United Fuel Gas Co. completed 6,268 fee Mineral, good for 5,666,000 cu. ft. gas in the Big lime, total depth 1,677 ft. In Center district, Wyoming County, United Producing Co. completed another well on the W. M. Ritter Lumber Co., No. 1493, which gaged 3,834,000 cu. ft. of gas, with the Maxton sand topped at 1,827 ft.; gas 1,871-94 ft., gas 1,923-32 ft., rock pressure 780 psi. in 48 hours, total depth 1,932 ft. In Oceana district, Hope Natural Gas Co. completed 9,194 Lillie Barrett good for 2,214,000 cu. ft. gas after shooting the Ravencliff sand, total depth 1,625 ft.

New locations totaled 29 and in Washington district, Boone County; Lee, Sheridan and Sherman districts, Calhoun County; Glenville district, Gilmer County; Grant and Ravenswood districts, Jackson County; Big Sandy, Cabin Creek and Elk districts, Kanawha County; Harts Creek district, Lincoln County; Logan and Tridelphia districts, Logan County; Liberty district, Marshall County; Cologne district,

Mason County; Jefferson district, Nicholas County; Clear Fork district, Raleigh County; Murphy district, Ritchie County; Grant district, Wayne County; Oceana district, Wyoming County.

SOUTHWEST PENNSYLVANIA SUCCESSFUL WILDCAT

Washington County: Morris Township: Josepth Johnson et al 1 Hiram Day, 2,900,000 cu. ft. gas, Big Injun sand 1,943 ft., gas 1,946-54 ft., rock pressure 640 psi., TD 2,000 ft.

WEST VIRGINIA SUCCESSFUL WILDCAT

Wyoming County: Oceana district: Hope Natural Gas Co. 9,194 Lillie Barrett, 2,214,000 cu. ft. gas, Princeton sand 1,478 ft., gas 1,511-14 ft., Ravencliff sand 1,548-1,640 ft., shot 1,624-40 ft., TD 1,625 ft.

CALIFORNIA

Cuyama Valley Hope Falls Again; Drill Pipe Lost

LOS ANGELES.—Supporters of the Cuyama Valley of San Luis Obispo County received one more disappointment last week with the abandonment of Navy Oil Co.'s prospective discovery there, the 1 Kirschenmann, 12-10n-27w. Circulation was lost in the well and drill pipe became stuck at a total depth of 5,127 ft. All efforts to recover the pipe failed, and the hole was given up with approximately 1,800 ft. of drill stem still in the hole.

The 1 Kirschenmann created considerable excitement 2 weeks ago when it cored 22 ft. of oil sand in the Santa Margarita at 4,950-72 ft. The cores, however, looked only fair and an electric log failed to lend added encouragement. Operators were in the process of carrying the well on down in search of possible deeper producing zones when the fishing job developed.

Failure of Navy's test places it in the same category as several other recent ventures drilled in the area. All of these have encountered oil sands but none has developed commercial production with the exception of Norris Oil Co. 2 Cuyama, 25-11n-28w, the initial discovery in the Cuyama Valley, completed earlier this year. Most geologists are of the belief that all of the wells have indicated considerable promise for the district as a whole and that several good structures may be uncovered by future drilling.

Navy Oil Co. has announced that it will begin another test on the Kirschenmann property within 30 days, and announcement last week by Richfield Oil Corp. that it had started grading location for 1 Russell, 5-10n-27w, marked the first activity of a major company in the area. Richfield's announcement indicates that it is nearing completion of a large leasing campaign with which it is unofficially reported to have tied up more acreage in the area than all other operators combined.

Rocket Petroleum Co.'s extension well of the Kern Bluff field of Kern County, the 1 Zinner Community, 12-29s-28e, has run into trouble and been taken off production. Completed for 125 bbl. daily from the Santa Margarita at 1,114-97 ft. last week, the well produced for 2 days and then went heavily to water, forcing a temporary shut down. A water witch has been run and indications are that the trouble is coming from the bottom of the producing zone. Operators, however, are not sure that the casing shoe is not leaking. Present plans call for pulling the liner and running a series of tests in order to locate and clear up the trouble.

A considerable increase in drilling in California during 1948 is indicated by notices of intent to drill filed during the first 3 months of the year by operators in the state. Notices filed during this period totaled 701 as compared to 529 for the same period of last year. New locations staked also continue to show an increase each week. During the past week operators staked locations for 84 new wells in the state, an increase of 26 over the number staked during the previous week. Heaviest concentrations of new locations were in the Cymric field, which received 9 prospective wells, Midway-Sunset, Coyote West and Huntington Beach with 7 each, Kern River with 6, and Wilmington with 5.

CALIFORNIA WILDCAT FAILURES

Kern County, Commanche Point area: Gene Reid Exploration Co. 6 fee, 32-12n-18w, dry, elev. 818 ft., Santa Margarita 600 ft., TD 650 ft.

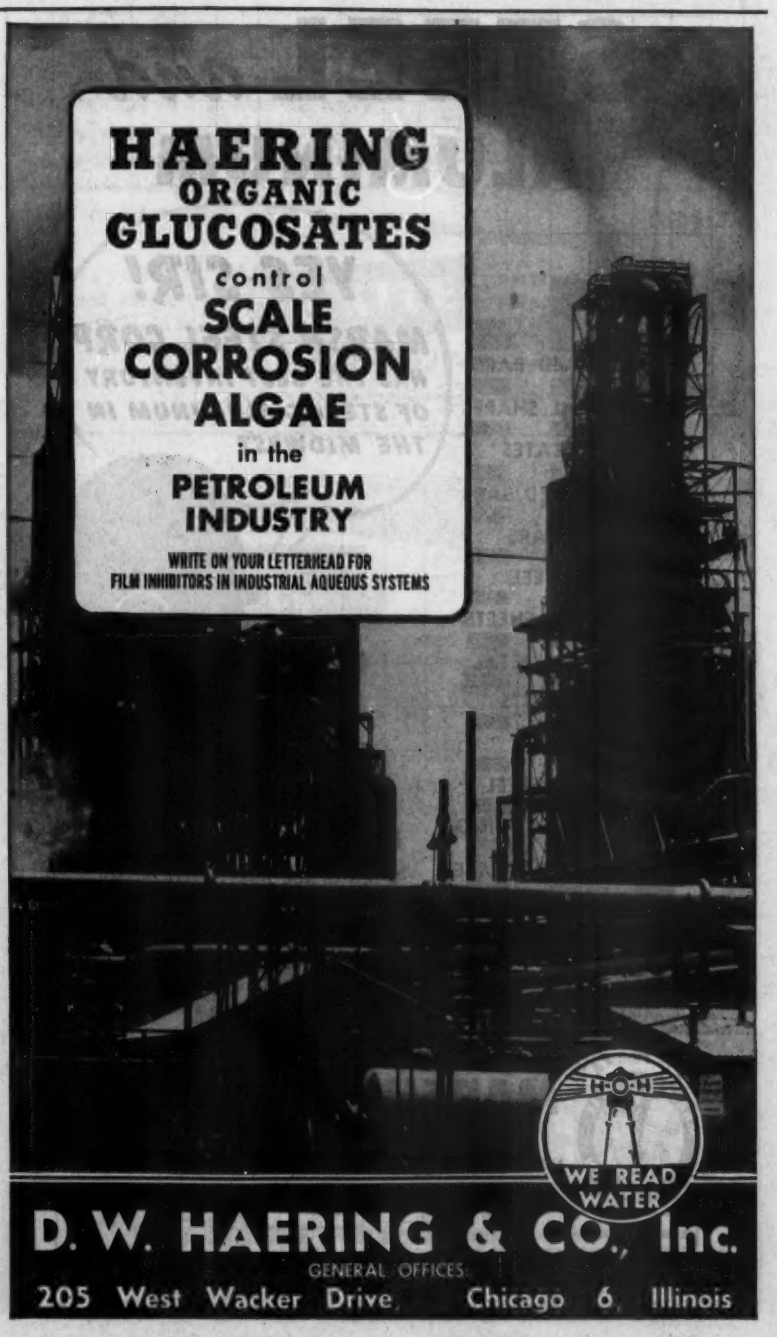
Orange County, Richfield area: Abercrombie & Porter 1 J. C. Travis, 31-3s-8w, dry in gray sand, elev. 335 ft., top sand 3,108 ft., TD 3,152 ft.

Ventura County, Saticoy area: Superior Oil Co. 1 Saticoy, 20-2n-22w, dry, elev. 183 ft., recovered fish to 11,189 ft., TD 13,581 ft.

CANADIAN FIELDS

Further Leduc Extension To South is Proven

CHATHAM.—A further important extension of Leduc field to the south has been proven by Okalta-Leduc 2, LSD 10, 33-49-26w4, about 1½ miles south of the nearest producer. Drill-stem test at 5,175 ft. gave some gas and oil-cut mud and at 5,222 ft. there was more gas, with 275 ft. of oil. At 5,244-61 ft. a gas flow at 300,000 cu. ft. a day, dropping to 150,000 cu. ft.,



was developed, with oil reaching the surface in 55 minutes. Production, from the D-2 zone, came from below the water line indicated in the nearest D-2 producer, Imperial Oil Co. 9. A major well is indicated, but the hole will be deepened to the D-3 zone.

West of the proven field, Globe-Leduc 7, LSD 5, 19-50-26w4, testing D-2 zone got 165,000 cu. ft. gas and 4,600-ft. oil rise around 5,200 ft. and is deepening to test the D-3 zone, contacted at 5,350 ft. The first D-3 core was highly porous with heavy oil saturation, and initial drill-stem test gave oil rise in 40 minutes with 90 bbl. an hour open flow and no water. Location is 2½ miles west of the previous established limits of D-3 production. Casing has been cemented for definite production test.

In the main field, Imperial 23, LSD 1, 21-50-26w4, finished at 5,125 ft., is on restricted production, making 80 bbl. through 12/64-in. choke. Imperial 24, LSD 12, 35-50-26w4, in drill stem test at 4,755-70 ft. had 205,000 cu. ft. gas with 2,500 ft. oil recovery, and is deepening. Imperial 32, LSD 16, 22-50-26w4, finished at 5,333 ft., is testing. Imperial 42, LSD 4, 36-50-26w4, in drill-stem test at 5,276-86 ft. had 2,250,000 cu. ft. initial gas flow with oil rise in 11 minutes. Imperial 49, LSD 3, 28-50-26w4, has spudded, and Imperial 60 is now location in LSD 11, 20-50-26w4. Imperial-Woodbend 3, LSD 9, 16-51-26w4, has spudded.

Home Oil Co. 5, LSD 12, 21-50-26w4, in drill-stem test of D-2 zone at 5,020-90 ft. had 250,000 cu. ft. gas with 3,120 ft. oil and 120 ft. mud. Test is deepening below 5,347 ft. in the D-3 zone, where initial drill-stem test showed 250,000 cu. ft. and 3,240 ft. oil recovery. It will be finished to produce from the D-3 zone, and another well drilled for D-2 production.

Atlantic Oil Co. 3, LSD 12, 23-50-26w4, bottoming at 5,331 ft., which blew wild on March 8 with maximum gas flow of 50,000,000 cu. ft. and potential oil flow of 200 bbl. an hour, is being plugged with cement and calseal. Derrick will be moved a quarter mile east to Atlantic 4, LSD 11, 23-50-26w4, following completion of which an offset to the plugged well will be drilled to test D-3 zone.

Pincher Creek.—Canadian Gulf - Pincher Creek 1, LSD 15, 24-3-29w4, bottoming in Madison limestone at 11,927 ft., on its most recent 24-hour run produced 328 bbl. with 9,200,000 cu. ft. gas. Well was later killed to permit deepening to the second porous zone of the Madison, but after tubing was pulled, the packer was found stuck. Canadian Gulf-Marr 1, LSD 1, 29-4-29w4, 7 miles north and west, has derrick up.

Peace River.—Imperial Oil is planning to drill this spring in the Peace River area of northwestern Alberta. Operations will be handled from Grande Prairie, near the British Columbia boundary, and will be concentrated on a triangle cornering at Pouce Cope, B. C., and Spirit River and Fairview, Alberta.

Lone Mountain.—Development of extensive holdings in the Lone Mountain area, near the Monkman Trail in northeastern British Columbia, will be undertaken this spring by Charles Mitchell of Vancouver and S. A. Annand of Calgary, who have obtained from the British Columbia provincial government oil and gas rights on 14,000 acres. The area, formerly isolated, was opened up by the Monkman Pass highway to connect the Peace River district of Alberta with the British Columbia highway system near Prince George. Gas seepages have been known in the area for many years, and recently Dr. George S. Hume of the Geological Survey of Canada pronounced the area the largest potential gas field in western Canada.

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KANSAS

Oil Above Mississippian at Seward County Wildcat

STANOLIND OIL & GAS CO. 1 Wheatley, C NE SW 23-33s-31w, Seward County, pumped 48 bbl. of oil and 30 bbl. of water in the first test above the Mississippian. Test was made in the Marmaton zone at 5,095-5,100 ft. through 31 perforations. Previous tests of the Mississippian through perforations at 5,815-5,915 ft. produced about 20 bbl. of oil and 7½ bbl. of water per hour. Total depth is 7,340 ft.

Stanolind Oil & Gas Co. 1 Bear, NW NW SE 17-32s-40w, Morton County on the west edge of the Hugoton gas field, will drill ahead to the Arbuckle after finding salt water in a drill-stem test of the Mississippian at 5,905 ft. The well had a show of 6,683 M.c.f. of gas in the lower Pennsylvanian at 4,990-5,017 ft.

In Reno County, Helmerich & Payne will drill ahead to the Arbuckle at 1 Stucky, SW SW SW 14-26s-6w. The well had two shows of oil and gas in the Mississippian, topped at 3,655 ft. The first test at 3,656-69 ft. with tool open for 6 minutes recovered 30 ft. of oil-cut mud and oil with gas estimated at over 6,000 M.c.f. The second test at 3,672-84 ft. recovered 180 ft. of fluid with oil and gas-cut mud and free oil. Well is located about 3 miles east of Pretty Prairie, Kans.

For the week a total of 40 locations were recorded. Ellis County led with five, followed by Butler and Russell with four each and by Cowley and Stanton with three each.

KANSAS SUCCESSFUL WILDCAT

Pawnee County: National Cooperative Refinery Association 1 Hutchinson, SE SE NW 17-23s-17w, produced 25 bbl. of oil per day from Kinderhook at 4,270-

87 ft.; Lansing 3,793 ft., Basal Kansas City 4,143 ft., sandy conglomerate 4,230 ft., cherty conglomerate 4,235 ft., Mississippi 4,238 ft., Misener 4,286 ft., cherty Viola 4,323 ft., Arbuckle 4,605 ft.

KANSAS WILDCAT FAILURES

Graham County: Harry Gore 1 Sayers, SE SE SE 27-7s-21w, dry, TD 3,605 ft., anhydrite 1,625 ft., Heebner 3,230 ft., Dodge 3,250 ft., Douglas 3,265 ft., Lansing-Kansas City 3,271 ft., conglomerate 3,523 ft., Arbuckle 3,572 ft. with good porosity at 3,574-78 ft.

Marion County: Anderson-Prichard 1 Davis, NW NW NW 21-21s-3e, dry, TD 3,011 ft., Mississippian 2,573 ft., Kinderhook 2,725 ft., Misener 2,870 ft., Hunton 2,872 ft., Maquoketa 2,889 ft., Viola 2,939 ft., Simpson 2,001 ft.

Pratt County: Mid-Continent 1 Fleming, NE NE NW 33-29s-13w, dry, TD 4,620 ft., anhydrite 755 ft., Lansing 3,920 ft., Mississippian 4,381 ft., Viola 4,429 ft., Simpson 4,469 ft.

Sedgwick County: Charles E. Gould 1 Allen, NW NW NW 14-27s-1w, dry, TD 3,200 ft., Lansing 2,632 ft., Basal Kansas City 2,803 ft., Mississippian 3,155 ft. with slight show of oil.

TEXAS GULF COAST

Sunray Opens New Field Northwest of Goliad

HOUSTON.—A new oil field for Goliad County, 6½ miles north-northwest of Goliad, in William Millican Survey, has been opened by Sunray Oil Corp. 1 Fannie O. Marshall. Operators are preparing to complete as a dual-gas-condensate well. Perforation tests at 9,170-92 ft. and 9,120-40 ft. had flowed gas with low pressure, and perforations at 9,060-9,100 ft. also tested low-pressure gas. Perforations from 8,970-83 ft. developed 2,525 psi. working pressure on ½-in. choke, and 3,000 psi. shut-in pressure, flowing mud with show of condensate, and recovered 95 ft. of condensate and fresh water. Final completion and perforations are not known as operators continue to test.

In southwest extension area of Arnim field, Fayette County, Phillips Petroleum Co. 1 Brown, 4 miles east of Waelder and in Gonzales County, gaged 5 bbl. of oil per hour, 30° gravity, through perforations at 2,976-81 ft. This well is located in the Adam Zumwalt Survey, Abstract 86.

Humble Oil & Refining Co. 1 Thompson Brothers Mineral Corp. et al, wildcat exploration 5¼ miles northwest of Glendale townsite in Trinity County, was mixing mud and trying to regain circulation at a total depth of 11,171 ft. Seven-inch pipe is cemented in the hole at 10,232 ft. Operators plan to carry the test down to 12,300 ft. Production of gas and condensate has been indicated in several levels, the last of which reported was in the Edwards lime section from 10,595-632 ft. Top of Edwards reported at 10,530 ft.

Hawkins-Graham Drilling Co. 1 Thomas A. Wheat et al, extended production of North Cleveland field in a westerly direction. Drilled to a total depth of 5,791 ft., this well gaged 163 bbl. of 40.6°-gravity oil per day through a ½-in. choke, flowing pressure on tubing 1,020 psi. and 1,480 psi. casing pressure. Production is through perforations at 5,784-86 ft.

General Crude Oil Co. 21-B Sun-Stanolind Esperson fee, deep exploration on the southeast flank of the Esperson dome, Liberty County, has been completed dry at total depth of 13,000 ft. still in the salt, with top at 10,704 ft. This well is located in the Angus McNeil Survey.

The 60 new locations reported for Districts 2 and 3 included 20 wildcat starts, 3 in Jackson, 2 each in Victoria and Washington, and 1 each in Brazoria, DeWitt, Fayette, Galveston, Goliad, Gonzales, Har-

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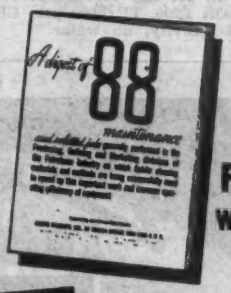

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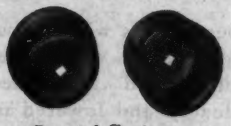

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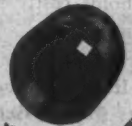

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ris, Lee, Live Oak, Matagorda, Newton, Refugio and San Jacinto counties. Three exploratory tests opened new pays, two gas and one oil, the gas pays being in DeWitt and Refugio counties and the oil pay in Liberty County. Four wildcats were dry, one each in Bee, Brazoria, Live Oak and Victoria counties.

GULF COAST TEXAS (DISTRICTS 2 & 3) SUCCESSFUL WILDCATS

DeWitt County: New gas pay Nordheim pool—Wescol O. & G. Co. 3 F. G. Gips, in Willis A. Moore Sur., top pay 7,350 ft., TD 8,400 ft., perf. 7,350-64 ft., IP: gas-condensate, no gage, shut-in pressure 2,400 psi., no water.

Liberty County: New oil pay South Liberty—L. M. Josey et al 4 Jcs. Mitchell estate, in M. G. White Sur., TD 6,465 ft., top sand 6,111 ft., perf. 6,111-16 ft., IP: 296 bbl. oil per day through 10/64-in. choke, GOR 1,200, TP 1,000 psi., CP 1,175 psi., 39°-gravity, no water.

Refugio County: New gas pay Refugio-Fox-La Gloria Corp. & Skelly Oil Co. 4-A Jamie Hynes, 3 mi. N of Refugio, in John Malone Sur., top pay 5,295 ft., TD 6,964 ft., perf. 5,295-5,319 ft., IP: 6,000,000 cu. ft. gas per day on open flow, shut-in pressure 2,120 psi., no water.

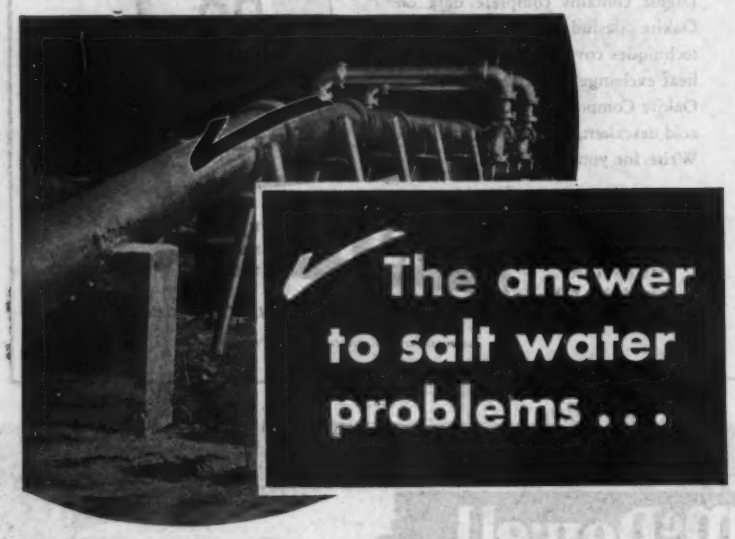
GULF COAST TEXAS (DISTRICTS 2 & 3) WILDCAT FAILURES

Bee County: Rowan & Hope 1 R. F. Schoolfield, in A. J. Davis Sur., 3½ mi. SW of Mineral and ½ mi. SE of Minoak field discovery, dry, TD 8,140 ft.

Brazoria County: Magnolia & Abercrombie 1 C. N. Maxwell, in S. F. Austin 7½ Lge., 3 mi. SE of Old Ocean production, dry, TD 12,490 ft.

Live Oak County: J. G. Gallagher 1 H. E. Palmer, in T. B. Sparks Sur., 4 mi. W of Whitsett, dry, TD 1,060 ft.

Victoria County: H. R. Cullen 1 Willett Wilson, in Weber Duler Subd. of Alejandro Esparaza Grant, 5 mi. SE of Keeran field, near Calhoun-Victoria county line, dry, TD 6,792 ft.



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OKLAHOMA

Offset to Eola Discovery Well Has Deep Show

SOHIO PETROLEUM CO. seems to be proving a new pay zone at 1 Dunlap, SE SW NE 17-1n-2w, offset to the discovery well in the Eola pool of Garvin County. Operator ran a drill-stem test at 10,643-10,717 ft. and recovered 7,000 ft. of fluid made up of the 1,000-ft. water load and 6,000 ft. of oil. The well had previously had oil in a test of the basal Bromide at 10,035-95 ft., the producing zone of the discovery well. Casing is set at 10,220 ft.

Testing continues at three wells in Lincoln County, each showing as a possible discovery well. Mid-Continent Petroleum Corp. is drilling ahead to the Wilcox at 1 Smith, NE NE SW 34-16n-6e. Operator swabbed 4½ bbl. of oil in 8 hours from pay at 3,854-99 ft. after treating with 1,000 gal. of acid.

Falcon-Seaboard Drilling Co. and L. W. Barrett 1 Bierman, NE NW NE 30-13n-5e, swabbed and flowed 15 bbl. per hour but testing was handicapped because a swab was lost in the hole. Casing was set on the first Wilcox at 4,987 ft. and total depth is 4,996 ft.

Anderson-Prichard Oil Co. 1 Cunningham, NE SW NW 22-14n-4e, had the Wilcox at 5,018 ft. Casing was set at 5,000 ft. and after cleaning out to 5,024 ft. the well swabbed ¼ bbl. per hour. Operator is shooting.

In Cleveland County about 2 miles north of Norman, J. F. Smith 1 Morrow Unit, 18-9n-2w, will receive another acid treatment after flowing 84 bbl. in 14 hours from the Bois d'Arc section of the Hunton through perforations at 7,253-7,300 ft.

Carter Oil Co. is testing the fifth oil well for Southeast New Hope pool in Garvin County, the 1 Hinkle, C SW SE 4-4n-3w. Tubing was run to 7,129 ft. and perforated at 7,106-18 ft. Open hole was 7,120-54 ft. After swabbing once, the well kicked off and flowed 257 bbl. in 4½ hours through ¾-in. choke. In the next 7½ hours the well made 301 bbl. through same choke and gas at the rate of 1,800 M.c.f. daily.

Fourdee-Rhodes Oil Co., Charles Walbert & Co. and Fidelity Royalty are rigging up rotary for 3 Burnside, NE SW SE 26-23n-1w, Noble County and Kingwood Oil Co. is planning to drill 6 Bolay, NE NE NW 35-23n-1w, to leave untested only one location on the narrow strip that may be the connecting link between the South and Southeast Ceres pools.

OKLAHOMA SUCCESSFUL WILDCATS

Creek County: Deardorf 1 Conner, SE NE NW 9-19n-7e, pumped 30 bbl. of oil per day from Skinner at 2,615-58 ft., TD 2,664 ft.

Oklahoma County: New pay in Jones—Big Chief Drilling 1 Estes, SW SW NE 23-13n-1e, pumped 53 bbl. of 38°-gravity oil per day from conglomerate at 4,561-67 ft., TD 4,580 ft.

OKLAHOMA WILDCAT FAILURES

Cotton County: Pickett 1 Walker, NE SW NW 6-2s-9w, dry, TD 3,161 ft., Priddy sand 2,198-2,215 ft., Zipse sand 2,640-88 ft., Armstrong sand 2,800-54 ft., sand 3,066-92 ft. and 3,112-40 ft.

Russell 1 Davis, E/2 E/2 NE SE 10-3s-11w, dry, TD 1,741 ft., sands 1,350-90 ft., 1,450-87 ft., 1,491-1,560 ft., 1,566-81 ft., 1,590-1,603 ft. and 1,606-88 ft., all dry.

Hutcheson 1 Whitehead, C SE SW 8-4s-12w, dry, TD 2,606 ft., no tops reported.

Grady County: Berkey 2 Thomas, SE NE NE 9-5n-7w, dry, TD 1,905 ft., sand 1,440-55 ft. and 1,839-50 ft.

Kay County: Peel 1 Warren, SW SW NE

32-29n-4e, dry, TD 3,675 ft., Pawhuska 1,210 ft., Elgin 1,320 ft., Upper Oread 1,632 ft., Lower Oread 1,840 ft., Tonkawa 2,002 ft., Layton 2,375-2,500 ft., Lenopah 2,691 ft., Big Lime 2,818 ft., Oswego 2,877 ft., Skinner 3,200-90 ft., Mississippi lime 3,227 ft., Simpson 3,595 ft., Arbuckle 3,631 ft.

Logan County: Jordan 1 Taylor, SW SE NE 6-15n-1e, dry, TD 5,172 ft., Deer Creek 2,170 ft., Dewey 3,470 ft., Hogshooter 4,050 ft., Checkerboard 4,312 ft., Oswego 4,780 ft., Skinner 4,937 ft., Bartlesville 5,044 ft., Mississippi lime 5,143 ft.

Porter 1 Wyant, NW NW NW 25-19n-2w, dry, TD 5,567 ft., Pawhuska 2,165 ft., Oread 2,885 ft., Avant 3,555 ft., Dewey 3,670 ft., Layton 4,025 ft. with slight show of oil, Checkerboard 4,495 ft., Oswego 4,670 ft., Verdigris 4,906 ft., Bartlesville 5,005-15 ft., Mississippi lime 5,070 ft., Woodford 5,250 ft., Viola 5,354 ft.

Noble County: McClelland 1 Holkum, SW SW NW 34-20n-1w, dry, TD 4,932 ft., Oread 2,552 ft., Avant 3,235 ft., Dewey 3,325 ft., Upper Layton 3,712 ft., Hogshooter 3,872 ft., Checkerboard 4,060 ft., Big lime 4,210 ft., Oswego 4,430 ft., Mississippi chat 4,878 ft., Mississippi lime 4,890 ft.

Okfuskee County: Wilcox 1 West, NE SE NW 1-12n-9e, dry, TD 3,782 ft., Oswego 1,447 ft., Senora sand 1,545 ft., Verdigris 1,836 ft., Inola 2,350 ft., Bartlesville 2,435-2,553 ft., Gilcrease 2,912 ft., Union Valley-Cromwell 3,066 ft., Mayes 3,380 ft., Woodford 3,545 ft., Sylvan 3,623 ft., Hunton 36,53 ft., Viola 3,700 ft., Wilcox 3,756 ft., second Wilcox 3,773 ft.

Payne County: Berry 1 Berry Estate, SE SE NW 19-19n-5e, dry, TD 3,955 ft., Layton 2,105 ft., Checkerboard 2,785 ft., Upper Oswego 3,110 ft., Lower Oswego 3,175 ft., Prue 3,250 ft., Verdigris 3,385 ft., Skinner 3,396 ft., Red Fork 3,507 ft.; Inola 3,615 ft., Bartlesville 3,638 ft., Mississippi lime 3,705 ft., Woodford 3,794 ft., Viola 3,862 ft., dense 3,885 ft., dolomite 3,892 ft., Wilcox 3,937 ft.

Seminole County: Harper 1 Grounds, NE SE SE 17-9n-6e, dry, TD 3,665 ft., Senora 2,960 ft., Booch 3,604 ft., Cromwell 3,650 ft.

ILLINOIS

Clay County Wildcat Has Good Show

MATTOON.—Diamond Oil Exploration Co. is testing the Cypress sand at 1 Toliver Woods Consolidated, NE SW NW 15-4n-7e, Clay County. After a 10-qt. shot, operator swabbed 125 bbl. of oil per day with no water. Production zone is at 2,602-16 ft.

In Wayne County Robinson-Puckett, Inc. has a very good well at 1 Arthur Wood, S½ NE NW 16-2s-8e, southeast of the Fairfield pool. Production is from the Aux Vases sand at 3,188-3,200 ft. and recent tests have averaged over 350 bbl. per day.

Calvert & Willis, Inc., Central Pipe Line Co., and Mahutska Oil Co. 1 Fred McKnight, NE NE SW 11-4s-10e, White County, has been acidized and flowed 220 bbl. of oil in 9 hours from the McClosky at 3,129-34 ft. Total depth is 3,144 ft.

ILLINOIS WILDCAT FAILURES

Coles County: Ernest Zink 1 G. Ingle, NE SE SW 2-12n-9e, dry, TD 952 ft.

Clay County: Ashland Oil & Refining Co. and Buchman 1 Kenley, SE SE SE 31-4n-8e, TD 3,095 ft.

Edwards County: O. D. Sharp 1 Frishel, NE NE SW 15-1n-14w, dry, TD 2,990 ft.

Saline County: Calvert & Willis 1 R. Ming, NW NW NE 21-7s-6e, dry, TD 3,253 ft.

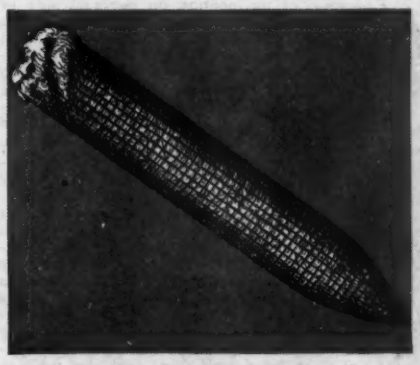
Jackson County: Black Panther Oil Co. 1 Holliday, NW NE SE 2-9s-1w, dry, TD 2,290 ft.

ROCKY MOUNTAIN

Wyoming Interest Revived With Two Pay Discoveries

DENVER.—Completion of two new pay discoveries in central Wyoming revived interest in known structures in these areas. In the Medicine Bow field Ohio Oil Co. recovered 50 bbl. of oil in 50-minute test of the Tensleep sand at 6 Kyle, NE SE NE 26-21n-79w, Carbon County, Wyoming, for a new discovery in that horizon for the field. Top of the Tensleep was found at 6,667 ft. and the well was drilled to 6,687 ft. total depth. The operator is now running casing and may drill the well deeper in the sand prior to completion. This field has produced from the Sundance sand for a number of years. A well drilled by Ohio in the SW SW NE Section 26 went to granite and had only shows in the Tensleep. This latter well was more than 300 ft. lower structurally than the new test. The oil from the Tensleep is 58° gravity, light green crude, in contrast to the 21°-gravity Tensleep oil produced in Quealy field, 30 miles south. The California Co. has an interest with Ohio in the Medicine Bow unit.

At 2 Wertz "D," SE SW NE 1-26n-90w, Wertz field, Sweetwater County, Wyoming, Sinclair Wyoming Oil Co. has made a Madison discovery. On drill-stem test between 6,780-6,851 ft. the well made 5,760 ft. of oil in 30 minutes through ¼-in. choke. Top of the Madison was found at 6,751 ft. and the well is at 6,921 ft., total depth, still in the Madison. The well also made oil on drill-stem test of the basal Amsden sand between 6,685-6,731 ft., flowing at the end of a 30-minute test in this



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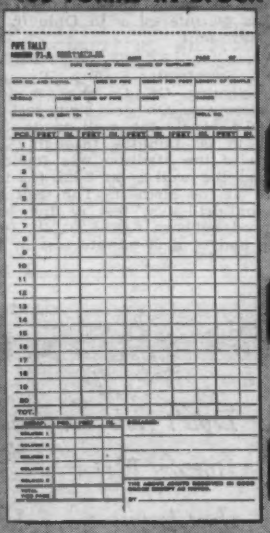

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zone. Sinclair established a new pay for Wertz field in the basal Amsden in February of this year at 22 Unit, CEL SE SE 1-26n-90w, and this well flowed 600 bbl. of oil daily through choke from that formation. Sinclair now has nine rigs running in Wertz and Lost Soldier fields in a development-drilling program for the Madison formation at Lost Soldier and the Amsden and Madison at Wertz.

Failure of the South Beaver Creek Syndicate of Denver to find the Newcastle sand in its interesting wildcat between the Mush Creek and Ant Hills pools may partially cool the activity in this area. The well is Harton, SW NW SE 26-42n-62w, Weston County, Wyoming, and the operator is now drilling below 4,900 ft. Three unidentified sands were encountered to 4,200 ft., but these were dry and did not have shows. The operators believe that the Newcastle sand was not encountered in the test. Present plans call for a test of the Minnelusa (Pennsylvanian) section at around 6,500 ft. This well is of importance because of its location on the east side of the Powder River Basin in the shore line area productive at Ant Hills and Mush Creek in the Newcastle sand. Some operators believe that several pools similar to Mush Creek field exist along the east side of the Basin, and leasing has been extremely active throughout the area as a result of Much Creek development drilling.

Saturation was encountered in the wildcat well east of Denver being drilled by Suhr, Trickett, and Fielder in Section 19-3s-66w, Adams County, Colorado. Top of the Hygiene was reported at 5,290 ft. with saturated sand topped at 5,411 ft. On drill-stem test at 5,408-27 ft. the well made only a small amount of mud and the operators were drilling ahead below 5,600 ft. Shows of oil in the Hygiene have been encountered by previous wells in the Denver area but none of these has been commercial. The operators may drill the well to Dakota at around 8,500 ft.

New operations.—Fourteen new locations were made, with eight in Wyoming, four in Montana, one in Colorado and one in northern New Mexico. In Wyoming an important new location was made in the Riverton area, Fremont County, by Atlantic Refining Co. This well, 1 Tribal, C SW SE 25-1s-4e (WRM), is located on lands acquired by Atlantic following a geophysical exploration campaign on Shoshone Indian tribal lands north of the Beaver Creek-Sand Draw area. The well will test the Frontier and Dakota-Lakota sands at around 7,500 ft. and may be drilled to Tensleep below 10,000 ft. An interesting Montana wildcat will be The Texas Co. 1 Northern Pacific Railroad, C SW SE 13-11n-27e, on Howard Coulee, Musselshell County. This well will be drilled to the Kibbey sand at around 4,800 ft. Kibbey is productive at Ragged Point, 15 miles east of Howard Coulee, where Texas completed the discovery well early this year, and is now drilling two additional wells on the structure.

Completions.—Thirteen wells were completed during the week, with a total initial production of 1,995 bbl. of oil. Four of the completions were in Wyoming, six in Colorado and one each in Montana, Utah and northern New Mexico. In Utah Carter Oil Co. has abandoned the third Vernal Unit wildcat and is drilling below 4,600 ft. on the fourth wildcat test of this block. These wells are drilled in an effort to find oil accumulation in stratigraphic traps of beds along the south side of the Uintah uplift in northeastern Utah. Shows of oil have been encountered in each of the wells, but no commercial production has resulted. In Colorado Jenkins Drilling Co. has abandoned a wildcat in the Red Mesa area, LaPlata County, in the San Juan Basin. The well had a small show of oil in the Dakota, but tests failed to recover more than shows of oil with water. Ames Management 1 Government, C NW SW 1-37n-63w, in the North Ant Hills area, Niobrara County, Wyoming, has been completed pumping 350 bbl. of oil daily from the Newcastle, for an excellent extension in that field. Other completions were pool wells.

WYOMING WILDCAT FAILURE

Snider Basin, Sublette County: The California Co. 1 Tierney, C NE NE 15-29n-115w, TD 9,544, dry, Twin Creek 2,450, Nugget 3,803 ft., Ankareh 4,530, Thaynes 5,338, Fault 5,448, Frontier 5,448, Aspen 6,890, Bear River 7,454, Beckwith 8,360, Twin Creek 9,478 ft., elev. 7,921 ft. DF.

COLORADO WILDCAT FAILURE

Red Mesa, LaPlata County: Jenkins Drlg. 1 Schmidt, SE SE SW 25-34n-12w (NMPM, TD 3,467, dry, Mancos 1,008, Dakota 3,210, Morrison 3,420, elev. 7,069 ft. ground.

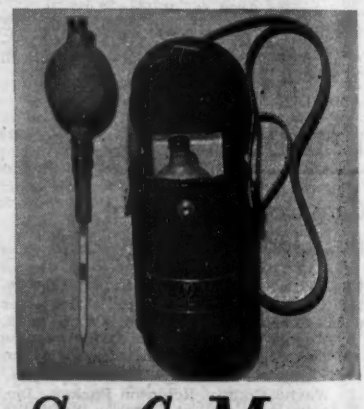
UTAH WILDCAT FAILURE

Vernal area, Uinta County: Carter Oil Co. 1 Schmide, C SE NE 28-4s-20e, TD 6,370, dry, Mesa Verde 4,020, Mancos 6,130, elev. 6,084 ft. DF.

LA.-ARK.

Bossier Parish Test Continues to Drill

SHREVEPORT.—In Boosier Parish, M. T. Halbouty and Stanolind Oil & Gas Co. 1 Bolinger-Boyd, 2½ miles east of Plain Dealing field in 30-23n-12w, was drilling below 5,950 ft., just out of the James limestone. Operators had cored between 5,529-41 ft., recovering 11 ft. of hard limy sand with streaks of shale and lignite, with no shows and salty taste. A drilling break at 5,579 ft. was circulated to recover sand with no shows. Cores between 5,628-46 ft. recovered 2½ ft. of hard gray limestone with spotted oil stains, but a drill-stem



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test from 5,630-46 ft., open 60 minutes, recovered only 3,100 ft. of salt water. Flowing bottom-hole pressure was 1,175 psi.

Kerr-McKee & E. E. Hurley 1 Frost Lumber, 14-11n-15w, DeSoto Parish, released the following sample tops: Saratoga 1,405 ft., Annona 1,685 ft., Austin 2,706 ft., Washita-Fredericksburg 2,757 ft., and Paluxy 2,875 ft., on elevation of 221 ft. It was coring ahead at 4,905 ft. Planned depth is 6,500 ft. to test the Travis Peak. On the south flank of Bull Bayou field in the same parish, The Texas Co. 1 Rambin, 23-11n-11w, was drilling at 7,001 ft. in Travis Peak.

In Lincoln Parish, W. C. Feazel 1 C. C. Barham Unit, 150 ft. north of the center, 21-20n-3w, was completed as a 3-mile east extension to Knowles-Hico field. After weeks of testing, potential was 115 bbl. of 60°-gravity distillate and 3,838,000 cu. ft. of gas a day through ¼-in. tubing choke. Production was from the Bodcaw sand at 8,510-30 ft.

Shell Oil Co., Inc., 37-A Frost Lumber, 12-22n-1w, became a ¾-mile north extension to the Ora field of Union Parish, when it was completed for 103 bbl. of oil and 155 bbl. of salt water from open hole at 2,098-2,108 ft. Top of the Nacatoch sand was 2,096 ft.

In Natchitoches Parish, Continental Oil Co. 1 Pardee Co., 30-12n-6w, was drilling below 9,900 ft. In Union Parish, C. M. Bagley 1 Auger, 36-23n-1w, was coring bil sand topped at 2,195-2,205 ft., and having trouble with salt water encountered at 2,205 ft.

PERMIAN BASIN

Schleicher County Wildcat Drilling Ahead After Show

MIDLAND.—Phillips Petroleum Co. 1 Mrs. M. J. Weddell, Section 72, Block M, GH&SA Survey, Schleicher County wildcat 11 miles southeast of Christoval, had considerable salt water on a second drill-stem test in the Pennsylvanian, tentatively identified as Strawn, after recovering oil and gas-cut mud. The first test, between 5,670-80 ft., open 2 hours, blew air immediately and showed gas at the top in 16 minutes. Total recovery was 315 ft. of drilling mud, lightly cut with gas, and a slight show of oil; 180 ft. of oil-cut mud, and 30 ft. of clean oil. Operators then drilled to 5,740 ft. and ran another 2-hour test with packer at 5,690 ft. Gas came to the surface in 30 minutes and recovery was 40 ft. of oil and gas-cut drilling mud, 1,220 ft. of free oil and 630 ft. of salt water. Projected depth is 6,500 ft., and operators were drilling ahead below 5,750 ft.

In Andrews County, Phillips 1-T Texas-University, 1 mile south of the Silurian discovery in the Shafter Lake area, Section 36, Block 13, University Lands, had total depth at 11,010 ft. and was said to be plugging back to around 10,000 ft. to try for completion in the Devonian.

Humble Oil & Refining Co. 1 Fred Turner, Jr., et al, prospective 1-mile north extension to Yates sand production in Fort Stockton field, Section 18, Block 119, SC&SF Survey, stopped at 3,010 ft., in the sand, to set casing to around 2,815 ft. The uncased section showed for a possible 30-ft. section of saturated limestone and sand.

Last report on Hale County's Cisco limestone discovery, General American Oil Co. 1 A. F. Byrd, 2 miles northeast of Petersburg, indicated it would not maintain a steady flow after a 3-stage acid treatment between 5,830-95 ft., and operators were to complete on the pump. It was swabbed continuously for 38 hours, recovering 15 bbl. of oil an hour.

In Sterling County, Anderson Prichard Oil Corp. and Vickers Petroleum Co. 1 Foster has placed tentative top on the Ellenburger as 8,200 ft., on an elevation of 2,475 ft. It was said to have shown little indications of production in the first 30 ft. of Ellenburger. Drilling stopped to run a test between 8,200-30 ft.

Gulf Oil Corp. et al 1 Grisham-Hunter, east-central Culberson County test, Section 16, Block 54, is still delayed by lost circulation. Total depth is 9,928 ft., in limestone. Operators pumped in 1,000 sacks of cement in the last attempt to fill the cavity.

Sixty-four locations, including four wildcats, made up the week's new work. Coke County received two wildcats, while Crockett and Culberson counties had one each. Field locations, by counties, were: Hockley 9, Pecos 9, Crockett 7, Winkler 7, Andrews 6, Ector 6, Mitchell 3, Upton 3, Cochran 2, Reeves 2, and 1 each in Coke, Gaines, Glasscock, Hale, McCulloch and Scurry. Week's completions totaled 62, being 48 oil wells and 14 dry holes. Wildcats accounted for 10 of the failures.

WEST TEXAS (DISTRICTS 8 & 7-C) WILDCAT FAILURES

Garza County: Humble Oil & Refining Co. 1-G fee, Sec. 136, Blk. 5, H&GN Sur., 4 mi. E Justiceburg, dry, TD 8,357 ft., Mississippi 7,760 ft., Ellenburger 8,015 ft., elev. 2,355 ft.

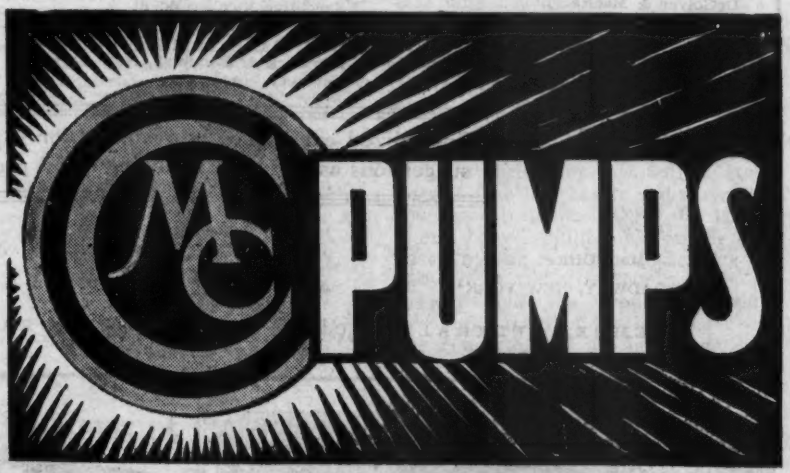
Glasscock County: Duncan Drilling Co. 1 Chicken Ranch, Sec. 17, Blk. 33, T&P Sur., 7 mi. N Garden City, dry, TD 2,700 ft.

Pecos County: Dave Elder 1 H. M. Holmes, Sec. 541, Brooks & Burleson Sur., 86 mi. S Grube, dry, TD 2,390 ft., sand withshow of oil 1,678 ft.

McDaniel & Beecherl Drilling Co. 1 Wilson, Sec. 23, Blk. 145, T&St.L Sur., 9 mi. SW Girvin, dry, TD 3,317 ft.

Reagan County: Moore Exploration Co. 1-D University, Sec. 10, Blk. 12, University Lands, 7 mi. S Big Lake, dry, TD 2,550 ft.

Runnels County: Drilling & Exploration Co. 1 C. E. Coats, M. P. Brewton Sur., 1 mi. E Tokeen, dry, TD 4,078 ft., Coleman Junction 1,365 ft., Flippen 1,975



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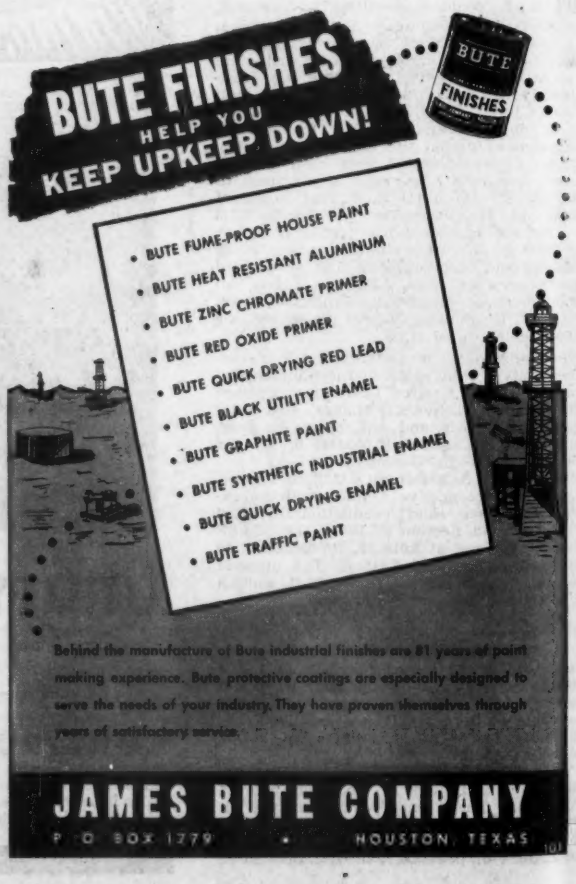

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ft., Gardner sand 3,905 ft., Gray sand 4,035 ft., elev. 3,030 ft.

E. S. Price 1 J. W. Reese, D. Diaz Sur. 532 9 mi. NE Ballinger, dry, TD 3,715 ft.

Sterling County: Plymouth Oil Co. 1 Willie Mae Foster, Sec. 56, Blk. 2, H&TC Sur., 11½ mi. NW Sterling City, dry, TD 8,384 ft., San Andres 2,000 ft., Glorietta 2,360 ft., Clear Fork 2,630 ft., Strawn 3,170 ft., Mississippi 8,260 ft., Ellenberger 8,313 ft., elev. 2,565 ft.

Terry County: Turner & Durham 1 Luther Bohanon, Sec. 74, Blk. DD, J. H. Gibson Sur., 3 mi. NE Seagraves, dry, TD 5,670 ft., anhydrite 2,423 ft., Yates 3,330 ft., San Andres 5,110 ft., elev. 3,382 ft.

Val Verde County: O. W. Killam 1 Everett, Sec. 138, Blk. 1, I&GN Sur., 11 mi. from north and 13½ mi. from west line of country, dry, TD 3,001 ft., show of oil 2,176 ft., elev. 1,563 ft.

SOUTHEAST NEW MEXICO SUCCESSFUL WILDCAT

Lea County: Gulf Oil Corp. 6 C. E. LaMunyon, NE NE 28-23s-37e, 1 mi. S of production in Monument area, Simpson 8,975 ft., McKee 9,344 ft., Ellenburger 10,195 ft., pay in McKee sand 9,344 ft., packer 9,295 ft., flowed 900 bbl. 41.5°-gravity oil a day, ¾-in. choke, GOR 650 cu. ft., tubing pressure 175 psi., elev. 3,294 ft.

SOUTHEAST NEW MEXICO WILDCAT FAILURE

Eddy County: York & Harper 1 State, NE NE SE 34-24s-27e, dry, TD 2,451 ft., Delaware limestone 2,297 ft., Delaware sand 2,445 ft., elev. 3,185 ft., hole full of sulfur water.

OHIO, KENTUCKY

Good Oil Well Struck In Portage County

COLUMBUS.—Roy Weed et al struck their second and better oil well in Aurora Township, Portage County, when they moved ⅛ mile southeast of the 3 Brandes to the 1 J. Twiss, Lot 19. The Clinton sand at 3,941-4,037 ft. had shows in both the red and lower white. After a 90-qt. shot, the well flowed 20 bbl. in 3 hours and 80 bbl. in 48 hours.

The Rock Ridge Co. has probably opened a new gas pool in the south center part of Parma Township, Cuyahoga County. A wildcat on George Shausheer, Lot 33, had an estimated 1,000,000 cu. ft. gas at 30 ft. in the second Clinton. The well was shut down until tubing could be brought in before drilling through the sand. The Upper Clinton at 3,007-20 ft. was dry and the second sand was topped at 3,074 ft.

Ditch and Gerig completed a fair well on Wm. Phillip, Lot 84, Harrisville Township, Medina County. The Upper Clinton at 2,785-90 ft. showed 50,000 cu. ft. of gas, and lower sand at 2,792-96 ft., an additional 231,000 cu. ft. When shut-in after shot, the well gaged 400,000 cu. ft.

Fierbaugh et al wildcat on C. W. Beach, Lot 21, Ruggles Township, Ashland County, is apparently dry. They have now drilled past the Clinton horizon without finding any sand.

Locations and completions are now coming in at a normal rate. Twenty-five locations in 12 counties were reported this week: Licking, Monroe and Perry counties each had 4. Brush Creek, Lancaster, and Stewart fields each had 5 of the 26 completions.

OHIO WILDCAT FAILURE

Tuscarawas County, Jefferson Township: Big Four O. & G. Co. 1 Philip Leonard, Lot 37, Berea 1,205-81 ft., TD 1,281 ft.

WESTERN KENTUCKY

OWENSBORO.—Ashland Oil & Refining Co. 1 Fannie Royster, 11-O-23, Henderson County, is another case where the reopening of an abandoned hole turned it into a producer. The well was abandoned in the latter part of 1944 with a total depth of 2,746 ft. Well was reopened, casing set, and plugged back to 2,526 ft. Perforations were made opposite the O'Hara at 2,502-11 ft. and the well swabbed 40 bbl. of oil and 12 bbl. of water in 16 hours. After acidizing it swabbed 50 bbl. of oil and 35 bbl. of water in 12 hours. Well is north of the Robards pool.

In Hopkins County George Engle, Rex Alworth, and Ashland Oil & Refining Co. 1 Proctor Ashby, SE SW SE 21-L-25, has been completed as a gas well in the Tar Springs at 2,219-46 ft. for an initial production of 10,843 M.c.f. of gas.

WESTERN KENTUCKY WILDCAT FAILURE

McLean County: R. H. Compton et al 1 O. L. Thurman, SE NW NE 18-L-28, dry, 1,728 ft.

INDIANA

EVANSVILLE.—Gibson County had an excellent completion in the George & Wrather et al 5A L. & A. Kieffer, NW SW SW 25-1s-12w. Well was completed in the Cypress after a 60-qt. shot at 1,955-75 ft. and shots of 75 and 30 qt. at 2,014-41 ft. for an initial production of 420 bbl. per day.

In Vanderburgh County George & Wrather 1 W. W. Scott, SE NW NE 9-5s-10w, is preparing to acidize to test the McClosky at 2,274-80 ft. Well swabbed mud and oil on preliminary tests. Total depth is 2,379 ft.

In the area northeast of the Martin pool in Vanderburgh County, Illinois Mid-Continent Co., J. A. Rose, D. L. Jobe, and Milton Lobree 1 Leo Schmitt, NE NE NW 30-4s-11w, is testing after perforating opposite the Aux Vases lime at 2,512-17 ft. and acidizing. Well had a show of oil in the Cypress sand at 2,228-40 ft. and was scheduled to test the St. Louis unless commercial production is found in shallower pays.

Problems of Hydrogen Sulfide Are Studied

(Continued from page 53)

organic finishes, according to G. R. Hoover, American Rolling Mill Co., because, if speckled, it leaves primer or paint over high spots. The use of a phosphate treatment gives best results, according to tests. This point was regarded as an important contribution to improving the painting of tanks.

In the presentation of awards at the banquet, Dr. Ulick R. Evans received the Willis Rodney Whitney Award in Corrosion Science and Dr. John M. Pearson received the Frank Newman Speller Award in Corrosion Engineering.

F. L. LaQue succeeded G. R. Olson as president of N.A.C.E. at the banquet. Other newly elected officers are: H. H. Anderson, vice president; O. C. Mudd, treasurer; and the following for a 3-year term: L. J. Gorman, director representing active members; D. E. Stearns, director representing associate members; and Vance N. Jenkins, director representing corporate members. A. B. Campbell continues as the association's executive secretary.

Abstracts of some of the papers contributing to the solution of corrosion problems of the oil and gas industries are presented in this issue on pages 91 and 92.

Record Production Is Essential, W.P.R.A. Told

(Continued from page 63)

"a curious idea that to assure national defense the federal Government must take control fo the industry." It should be remembered, he said, that the only resources which were not immediately available for the prosecution of the last war were those owned by the federal Government itself. After 4 years of effort, production at Elk Hills Naval Oil Reserve was only "a trickle."

The functions and makeup of the present National Labor Relations Board and features of the Taft-Hartley law were described in another W.P.R.A. general session talk by J. Copeland Gray, board member.

It is too early, Gray said, to judge if the Taft-Hartley law will be successful. The law hasn't had a chance to demonstrate itself, and the board is still busy deciding old Wagner Act cases, having reduced the backlog of these from 4,000 to 1,300.

Gray told the group that one accomplishment of the law had been the conclusion of an agreement between the general contractors and the A.F. of L. building-trades unions which settles jurisdictional strikes "the minute they come up." Injunctions authorized in some cases under the new law, have not been misused and have been resorted to less than was though, Gray said.

The fourth general session speaker was W. T. Holliday, president, Standard Oil Co. (Ohio), who, speaking on "World Federation," told the association that "wars have never been ended by power politics." Wars, he said, will be prevented through law and order which requires some kind of government. He discussed a world federation in which representation would be weighted according to cultural, social, and industrial development.

Gasoline Tax Revenues Show February Increase

WASHINGTON.—Collections from the federal gasoline tax in February were some $2,370,000 above those of the same month last year, but receipts from the levies on lubricating oil and pipe-line transportation fell off sharply, it was reported by the Internal Bureau March 29.

The revenue from gasoline was $36,035,600 against $33,662,335 in February 1947, the bureau announced. Collections from lubricating oil, however, dropped to $5,859,012 from $8,568,023 and from pipe-line transportation to $1,578,386 from $2,123,697.

STATISTICS and

WEEKLY WELL COMPLETIONS . . . WEEK ENDED APRIL 10, 1948

	Total of all wells					Cum.		Wildcat completions and discoveries					Cumulative total, 1948				
	Comp.	Oil	Gas	Dry	Footage	1948	1947	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
New York	31	16	0	*15	36,421	431	378	0	0	0	0	0	0	0	0	0	0
Pennsylvania	52	24	4	†24	112,604	789	875	0	0	1	0	1	0	0	5	11	16
West Virginia	14	2	11	1	25,977	205	229	0	0	1	0	1	2	0	16	19	37
Ohio	26	5	10	‡11	64,595	339	342	0	0	0	1	1	1	0	4	9	14
Indiana	10	4	1	5	16,200	248	147	0	0	0	0	0	2	0	0	4	6
Kentucky	12	2	1	9	18,866	165	129	0	0	0	1	1	2	0	0	4	6
Illinois	16	10	0	16	59,840	516	506	0	0	0	5	5	10	0	0	89	99
Michigan	8	3	1	4	18,283	175	167	0	0	1	4	5	5	0	5	70	80
Kansas	40	23	2	15	123,026	693	705	1	0	0	4	5	9	0	1	85	95
Neb., Mo., Iowa	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Oklahoma	65	34	3	§28	231,585	991	1,139	2	0	0	11	13	35	3	6	164	208
Texas	229	130	13	86	964,157	2,887	2,293	*3	0	4	46	53	83	8	31	519	641
North Central (Dist. 7-B & 9)	71	34	0	¶37	208,694	856	695	1	0	0	15	16	34	0	6	165	205
West (Dist. 7-C & 8)	62	48	0	14	276,620	778	545	0	0	0	10	10	10	0	1	58	69
Panhandle (Dist. 10)	12	8	3	1	34,920	159	130	0	0	0	0	0	0	0	1	3	4
Eastern (Dist. 5 & 6)	15	6*	1	8	76,111	156	134	0	0	0	4	4	4	0	0	40	44
Gulf Coast (Dist. 2 & 3)	31	18	5	8	197,057	451	447	1	0	2	4	7	22	7	7	114	150
Southwest (Dist. 1 & 4)	38	16	4	18	170,755	485	342	1	0	2	13	16	13	1	16	139	169
Louisiana	17	11	0	6	86,893	477	322	1	0	0	1	2	8	5	1	49	63
Northern	10	5	0	5	32,491	303	156	0	0	0	0	0	0	0	0	23	23
Southern	7	6	0	1	54,402	174	166	1	0	0	1	2	8	5	1	26	40
Arkansas	0	0	0	0	0	79	69	0	0	0	0	0	2	0	0	21	23
Mississippi	5	4	0	1	35,424	107	95	0	0	0	0	0	2	0	3	24	29
Southeastern States	2	0	0	2	12,624	12	14	0	0	0	2	2	0	0	0	11	11
Montana	1	1	0	0	1,532	65	42	0	0	0	0	0	1	0	0	7	8
Wyoming	4	2	0	2	22,386	103	58	0	0	0	1	1	5	0	0	13	18
Colorado-Utah	7	5	0	2	35,705	74	50	0	0	0	2	2	0	0	0	14	14
New Mexico	10	6	1	3	40,357	167	146	1	0	0	1	2	3	1	0	10	14
California	62	55	0	7	225,645	753	528	0	0	0	3	3	6	0	0	69	75
Total United States	621	337	47	237	2,132,120	9,276	8,236	8	0	7	82	97	176	17	72	1,192	1,457
Total previous week	619	352	45	222	2,243,258	8,655	7,688	11	1	3	79	94	168	17	65	1,110	1,360
Total April 12, 1947	548	300	54	194	2,109,550			18	5	6	54	83	175	25	44	1,025	1,269

Service wells included: *15, †24, ‡1, §2, ¶3.

CRUDE PRICES AND REFINERY ACTIVITY

GRAVITY SCHEDULES

Top prices include all gravities above grades designated, and low prices include all gravities below grades designated:

Gravity—	Signal Hill, Calif.	Oklahoma, Kansas	Gulf Coast Tex.*	West Tex.†
18-18.9	$2.17	....	....	....
19-19.9	2.19	....	....	....
20-20.9	2.21	$2.25	....	$2.12
21-21.9	2.23	2.27	....	2.14
22-22.9	2.27	2.29	....	2.16
23-23.9	2.30	2.31	....	2.18
24-24.9	2.34	2.33	$2.86	2.20
25-25.9	2.38	2.35	2.86	2.22
26-26.9	2.41	2.37	2.80	2.24
27-27.9	2.45	2.39	2.83	2.26
28-28.9	2.49	2.41	2.84	2.28
29-29.9	2.52	2.43	2.86	2.30
30-30.9	2.56	2.45	2.68	2.32
31-31.9	2.59	2.47	2.70	2.34
32-32.9	2.62	2.49	2.72	2.36
33-33.9	....	2.51	2.74	2.38
34-34.9	....	2.53	2.76	2.40
35-35.9	....	2.55	2.78	2.42
36-36.9	....	2.57	2.80	2.44
37-37.9	....	2.59	2.82	2.46
38-38.9	....	2.61	2.84	2.48
39-39.9	....	2.63	2.86	2.50
40 and above	....	2.65	2.88	2.52

*For crude from Daboval, El Campo, and Sand Point. †Includes Lea County, New Mexico.

A.P.I. REFINERY REPORT, WEEK ENDED APRIL 3

(Thousands of barrels)

District—	Crude runs, daily avg.	Production: Gasoline†	Kerosine	Gas & dist. oil	Residual	Stocks at refineries, bulk terminals, in transit and in pipe lines: Gasoline*	Kerosine	Gas & dist. oil	Residual
East Coast	873	2,110	329	1,257	1,700	24,011	3,979	8,314	7,512
Appalachian:									
District 1	98	277	55	78	76	2,284	159	317	300
District 2	71	216	28	64	130	2,223	123	172	102
Ind., Ill., Ky.	860	2,877	421	956	1,115	21,888	1,933	3,746	3,039
Okla., Kans., Mo.	426	1,458	258	497	512	11,005	552	1,537	1,422
Inland Texas	234	1,032	110	145	464	4,332	352	290	871
Texas Gulf Coast	1,383	3,638	748	2,319	1,902	19,238	1,305	4,172	4,991
La. Gulf Coast	434	1,280	351	772	582	5,650	961	2,114	1,519
N. La. and Ark.	77	239	67	107	138	2,380	269	361	128
Rocky Mountain:									
New Mexico	11	39	4	10	26	89	25	16	30
Other Rocky Mtn.	139	359	34	176	291	3,219	129	673	716
California	869	2,325	79	1,205	2,148	18,211	1,143	10,468	27,329
April 3, 1948	5,475	15,850	2,484	7,586	9,084	113,530	10,930	32,180	47,959
March 27, 1948	5,324	15,783	2,647	7,682	8,854	112,991	10,459	30,717	48,334
April 7, 1947	4,732	14,342	2,138	5,558	8,149	105,330	9,556	31,098	43,446

*Finished and unfinished. †At refineries including natural blended.

Bureau of Mines crude-oil stocks 223,015,000 bbl. as of April 3—up 201,000 bbl. One year ago 230,401,000 bbl.

FLAT CRUDE PRICES

Representative posted schedules per bbl.			
East Texas	$2.65	Pecos County, Texas (Yates)	2.35
Kettleman Hills, California*	2.14	Bradford, Pennsylvania	5.00
Beauregard Parish	2.60	Eastern Ill. and Western Ind.†	2.77
Illinois Basin	2.77	Tomball, Texas Gulf Coast	2.83

*37°-37.9°. †35° and above.

TRENDS

DAILY AVERAGE PRODUCTION FOR WEEK

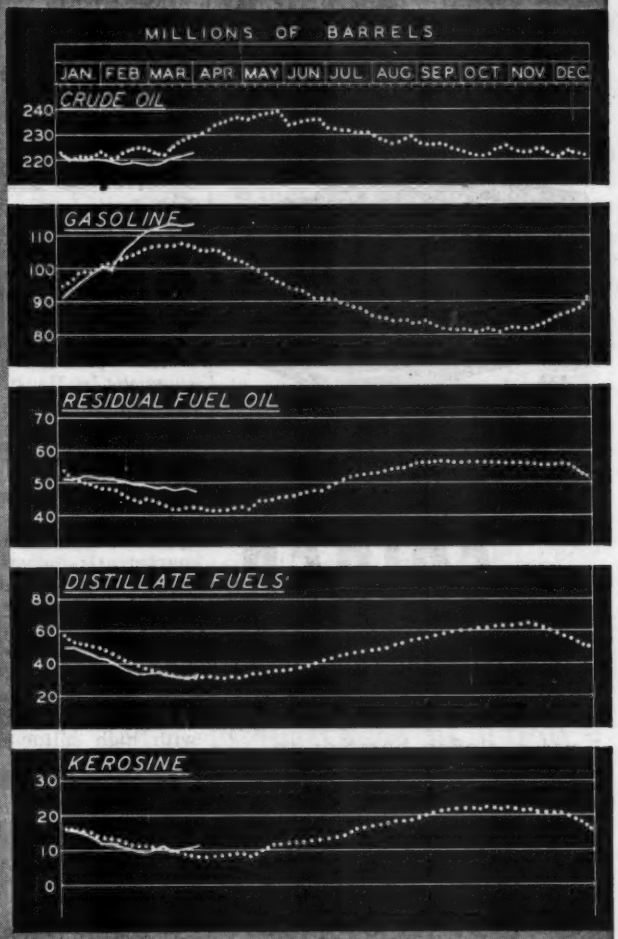
	April 10 crude oil	B. of M. April demand	April 3 crude oil
Alabama	1,350	1,500	1,000
Arkansas	87,700	83,000	87,100
California	943,100	930,000	945,300
Colorado	45,200	48,000	45,080
Eastern	67,950	64,900	67,100
Florida	825	1,000	825
Illinois	174,600	178,000	174,500
Indiana	19,200	16,000	18,300
Kansas	284,300	304,000	303,450
Kentucky	24,600	26,000	24,300
Louisiana	479,700	475,000	480,175
North Louisiana	125,300	.....	126,200
South Louisiana	354,400	.....	353,975
Michigan	45,100	46,000	42,350
Mississippi	111,185	116,000	115,235
Montana	22,750	24,000	23,270
Nebraska	450	600	450
New Mexico	127,600	129,000	128,375
Oklahoma	402,200	415,000	397,250
Texas	2,419,000	2,450,000	2,408,525
Dist. 1 (Southwest)	25,800	.....	25,625
Dist. 2 (Southwest)	172,350	.....	171,200
Dist. 4 (Southwest)	253,400	.....	253,275
Dist. 3 (Gulf Coast)	493,300	.....	492,175
Dist. 5 (Eastern)	46,125	.....	44,550
Dist. 6 (Eastern)	121,400	.....	121,300
East Texas Field	316,500	.....	320,200
Dist. 7-C (West)	44,400	.....	44,100
Dist. 8 (West)	679,325	.....	672,100
Dist. 7-B (W. Central)	44,550	.....	43,725
Dist. 9 (N. Central)	137,600	.....	136,500
Dist. 10 (Panhandle)	84,250	.....	83,775
Wyoming	143,450	142,000	140,400
Total United States	*5,400,260	5,450,000	5,402,985
Change from prev. wk., dn.	2,725		

Total production January 1-April 10 ..... †546,200,935 bbl.
Same period last year (crude plus cond.).. 480,077,315 bbl.

*Not incl. 55,480 bbl. condensate. †Incl. 5,198,975 bbl. condensate.

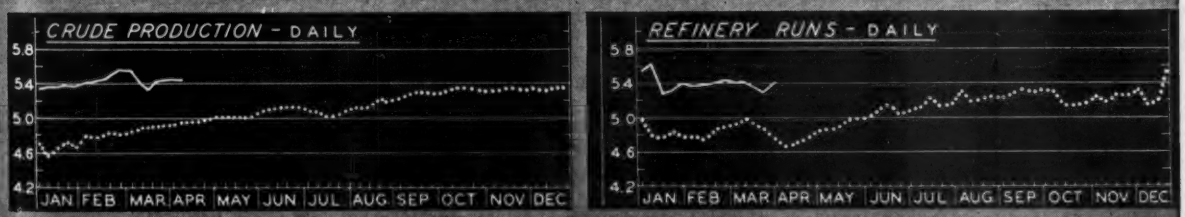
STOCKS IN UNITED STATES

---- 1947 ——— 1948



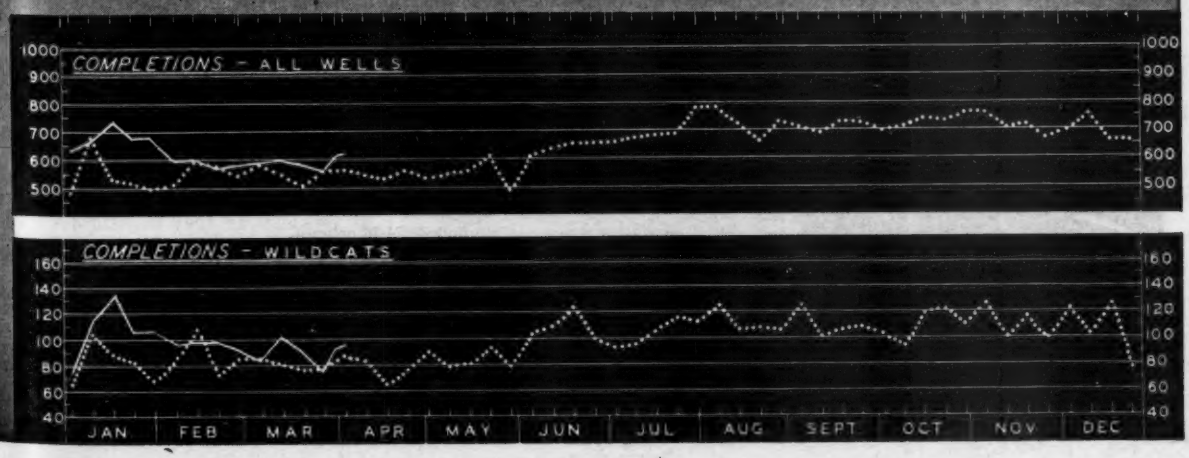
DAILY OPERATIONS

---- 1947 ——— 1948



WEEKLY COMPLETIONS

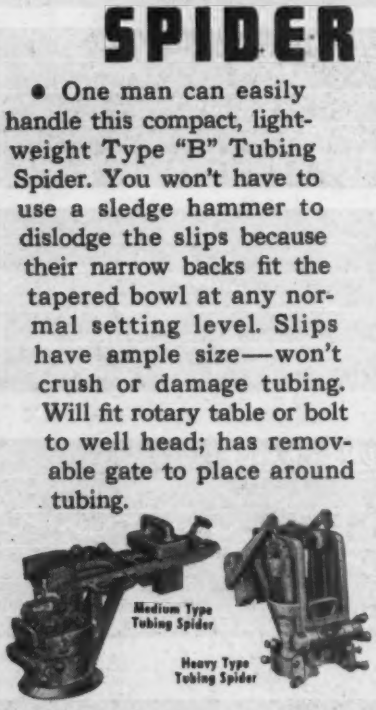
---- 1947 ——— 1948



SLIPS WON'T STICK

with Guiberson TUBING SPIDER

• One man can easily handle this compact, lightweight Type "B" Tubing Spider. You won't have to use a sledge hammer to dislodge the slips because their narrow backs fit the tapered bowl at any normal setting level. Slips have ample size—won't crush or damage tubing. Will fit rotary table or bolt to well head; has removable gate to place around tubing.



Type "B" is available with 5 slip sizes, 1" to 3". Other Guiberson Spiders are the automatic "Medium" and "Heavy" Types. For complete data see the Composite Catalog, Pages 1540-44.

REG. U. S. PAT. OFF.

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Guiberson U. S. A.

Established 1919

THE GUIBERSON CORPORATION

GENERAL OFFICES: DALLAS, TEXAS
EXPORT OFFICE: 30 Rockefeller Plaza, New York 20.
CALIFORNIA DISTRIBUTOR: W. E. Gu berson Co., 717 E. Gage Avenue, Los Angeles 1.
BRANCH OFFICES: Oklahoma City and Tulsa, Okla.; Alice, Houston, Kilgore, Longview, Odessa, and Wichita Falls, Tex.; Lafayette, La.; Wichita, Kan.; Newark, Ohio.

MARKETS

ON the Atlantic Coast prices remained generally unchanged. Only Shell Oil Co., Inc., and one New York Harbor independent supplier has followed Esso Standard Oil Co.'s summer discounting policy. There was no indication that others would follow Esso's lead in cutting prices on 350 specialty petroleum products. Primary suppliers were reported studying the situation and one was reported to have decided "definitely not to follow."

On the Gulf Coast activity in petroleum products markets continued sluggish. In Houston marketers said the condition was purely seasonal and that an upturn in both motor fuel and burning oil is expected soon.

No. 2 Soft

Meantime, however, most products appeared to be moving on the spot market at publication prices or only slightly higher. This was in marked contrast to the situation several weeks ago when products were commanding premiums ranging up to 3 cents. No. 2 was said to be soft with sales ranging up to 10½ cents. Low-sulfur No. 6 was moving around $2.75 with high sulfur material at about $2.50.

In the Mid-Continent area an apparent drop in demand for No. 2 was reported by one supplier with a noticeable increase in demand for diesel oil to take the place of No. 2. Good clean No. 2 was moving at 9½ to 10½ cents.

Continued tightness in gasoline movement was reported in the Mid-Continent area. Price levels remained unchanged but an increasing number of inquiries was reported. Price level for regular-grade gasoline ranged between 11½ cents to as high as 13 cents which according to one marketer was merely a "brush off." One buyer reported that some "third rate" gasoline was moving at round 10¾ cents.

Natural gasoline price levels remained firm and unchanged with demand increasingly heavy. Numerous requests from refiners were an indication of the increasing demand for gasoline. Clean tank cars were reported tight and getting "tighter all the time."

One source said he found tank cars a "shade easier" to obtain during the past week, but that he felt it was probably a temporary situation and that they would soon become tight again.

No. 6 Unchanged

Spot sales on No. 6 in the Mid-Continent area continued soft. No apparent influence on this product was reflected from the present coal strike. Probably the greatest adverse effect to the oil industry will be felt in the reduction of the already limited supply of steel resulting in a further curtailment of much needed tubular goods.

One Mid-Continent supplier reported that his shipments of No. 6 for steel industry consumption has remained unchanged despite the coal strike, but that this condition would not remain the same if the strike continued.

Suppliers in the Michigan and Minnesota areas continued to voice their concern that they are approaching the peak of the planting season with little or no tractor oil or gasoline, and little prospect of getting any. According to one government official enough tank cars are in sight "to go a long way toward moving vitally needed tractor fuel to Minnesota farmers."

Bunker diesel at Tampico and Minatitlan, Mexico, is now $3.75 per barrel, effective April 8.

Representative Quotations

Representative spot-market quotations of leading suppliers as of April 12, 1948. Figures are f.o.b. plant for tank-car shipment in cents per gallon, except for residual fuel oil which shows the price per barrel and wax, in cents per pound.

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor	Texas Gulf Coast
Regular gasoline, 73-75 octane	10½-11½	11.6-12* 10.5-12.2†	10.9-11½
Premium gasoline, 78-80 octane	11¾-12½	10.6-13.4	12.9-13
42-44 w.w. kerosine	9½-10½	10.2-12.2	10¼-12
No. 2 straw fuel oil	9½-10	9.3-11.1	9.05-11
No. 6 residual	$2.50-2.85	$3.03-3.90	$2.56-3.00

*Branded (74-76 octane); †Unbranded (74-76 octane).

NATURAL GASOLINE

	Group 3	North Texas	N. La.
Grade 26-70	8½	8	8¼
Grade 18-55	10.2	9.6	9.9

LUBRICATING OILS

South Texas	
200 vis., No. 2-3 neutral	13-14.5
750 vis., No. 3-4 neutral	15-17.25
2,000 No. 5-6 neutral	17-18½

LUBRICATING OILS

Mid-Continent	
150-160 vis., D bright stock, 0-10 pp.	30-33
200 vis. No. 3 neutral, 0-10 pp.	20-21
Western Pennsylvania	
145-155 vis. 10 p.t. bright stock	47
180 vis. p.t. neutral	45

CRUDE-SCALE WAX

Mid-Continent	
130-132 A.S.T.M. melting point	7¼-8

EQUIPMENT MEN ... in the News

D+B Announces Personnel Changes

F. L. PROSSER

Emsco Derrick & Equipment Co. announces three changes in key personnel. The position of manager of the D+B Mid-Continent division has been assigned to F. L. Prosser. Herschel Lewis was promoted to Mid-Continent sales manager to fill the position vacated by Prosser, and JoEarl Morris assumed the duties of assistant sales manager previously held by Lewis.

H. LEWIS

JOEARL MORRIS

Frank Prosser joined the Emsco organization in 1936 as representative of the D+B division in South Texas. In 1940 he established the first Continnental D+B store, which was located at Freer. In 1942, Prosser was transferred to Dallas as manager of stores for the purpose of installing field stores in Texas, Oklahoma, and Kansas. Upon completion of several new field stores, he was promoted to assistant sales manager and in 1944 was made sales manager. Before joining Emsco, Prosser served with the Santa Fe Railroad, Shell Oil Co., Inc., and Roxana Petroleum Corp.

Lewis spent 9 years with Gulf Oil Corp. in various capacities ranging from roustabout to field foreman in charge of production activities. Lewis was employed with Lamtex Equipment Corp., Fort Worth, until he joined Emsco in 1944 as manager of stores. Before assuming his present position he was assistant sales manager of D+B.

Morris joined the Emsco organization in 1940 as D+B storeman at Freer. In 1941 he earned the post of district manager for South Texas. After serving in the Army Air Forces with the rank of captain, he returned to Emsco in 1945 as district manager in charge of the Continental D+B store at Odessa and West Texas-New Mexico operations.

Formica Holds Stockholders Meeting

Stockholders of Formica Insulation Co. at the annual meeting recently reelected all directors and added Stuart L. Faber, a son of Herbert A. Faber, cofounder of the busines with D. J. O'Conor, president, to the board.

At the directors meeting, Daniel J. O'Conor, Jr., a son of the company president, was advanced to the position of executive vice president. He had been a vice president with title of assistant to the president and a director during the past year.

Other officers of the company reelected included: D. J. O'Conor, president; W. J. Gebhart, vice president and treasurer; George H. Clark, vice president and chief engineer; J. Roger White, vice president in charge of sales and advertising; Robert W. Lytle, vice president in charge of special engineering; Ellsworth G. Williams, vice president in charge of manufacturing; and Walter H. Kruse, secretary.

Steele in Charge of Mud School

Ed Steele, mud engineer for Oil Base, Inc., has been appointed to supervise the mud school to be held in Bakersfield, Calif.

Held under the auspices of the American Association of Oilwell Drilling Contractors, classes began in March at Long Beach. Tentative plans call for similar schools in Bakersfield, Whittier, Ventura, and Coalinga

White Elected Franks Vice President

R. M. "Dick" White has been elected vice president and appointed sales director of Franks Manufacturing Corp. of Tulsa as of April 15. White, who has been Franks district manager at Fort Worth, has been with the company since 1934, except for brief periods with Noble Drilling Co. as roughneck in the field, and with Oklahoma Iron Works as rotary-rig engineer.

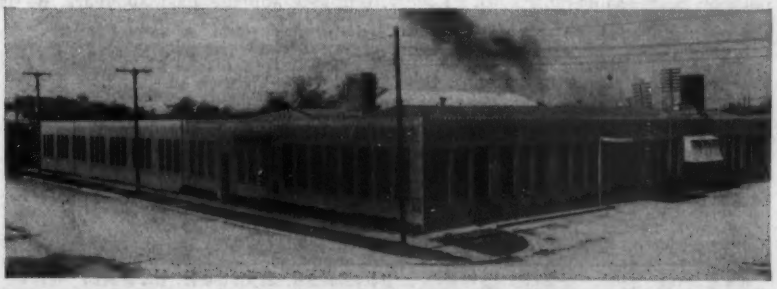
He was born in Cincinnati in 1899 and received his education in three colleges, Spring Hill Preparatory College in Mobile, Ala., at Tulane in New Orleans, and at Notre Dame where he majored in engineering.

Following college, White became a salesman for and part owner of C. D. Gott Co. of Chattanooga, Tenn., and was salesman for Aberfoile Manufacturing Corp. of Chester, Pa., before joining Franks.

White has spent most of his time with Franks in the sales department. He established the Fort Worth office and for years covered all of Texas, New Mexico, Louisiana, Mississippi, and Arkansas.

Abbett Establishes Firm

Paul Abbett, formerly office manager, Williams Brothers Co., Puerto la Cruz, Venezuela, has established a business carried on in his own name



More than 2,000 guests visited the Browning-Ferris Machinery Co.'s Houston plant recently at an open house featuring the International Harvester TD-24 tractor. Also featured was the formal opening of new warehouse, shop, and service facilities. James Melton, radio star of the International Harvester "Harvest of Stars" program, was an honor guest at the open house

with headquarters at 501A Industries Building, New Orleans.

Abbett represents oil companies and construction organizations operating in Central and South America in connection with the purchase and forwarding of supplies and equipment. His service is particularly for firms which do not have their own purchasing organizations in the United States.

Thompson Joins Frontier Chemical

Courtenay M. Thompson, formerly southwestern sales manager for Southern Alkali Corp., has joined Frontier Chemical Co., electrochemical manufacturers of Midland and Denver City, Tex., as sales manager. Thompson, a graduate of Harvard University, has been active in the alkali industry in the Southwest since 1940, except for service during the war as a chemical-warfare procurement officer in New York, as a company commander in a 4.2 mortar battalion, and as an intelligence officer with Stilwell's forces in Burma and India. Thompson will be located at Frontier's general office, Midland Tower, Midland.

Kennedy Elects New Officers

C. F. KENNEDY

Kennedy Valve Manufacturing Co., Elmira, N. Y., has announced the election of Charles F. Kennedy as president. Kennedy has been with the company since he was graduated from University of Michigan in 1937. He was promoted from assistant works manager to vice president and works manager in June 1947. He is a grandson of the late Daniel Kennedy who founded the business in 1877.

Matthew E. Kennedy, who has been president of the company since 1928, was elected chairman of the board of directors and will also retain his position as treasurer.

Gregory and Elizardi Appointed

William Bres Gregory, who has been associated with A. M. Lockett & Co., Ltd., since 1926, and assistant manager of the firm's Dallas office since 1940, has been appointed manager of the Dallas district office to succeed Henry B. Chambers, Jr., recently deceased.

Frank P. Elizardi has been appointed assistant to the vice president of A. M. Lockett & Co., Ltd. While Elizardi's headquarters will be in the Dallas office his work will take him all over the state of Texas.

Landgraff to South America

Ed T. Landgraff, manager, New York office of Chiksan Export Co., will leave shortly on a 4-month trip to South America. Landgraff will cover all the important oil-producing centers on his itinerary, renewing acquaintances among oil men in those areas and establishing resident representatives in the various countries for Chiksan swivel joints, Well Equipment Manufacturing Corp. products, and Okadee valves, which are sold exclusively by Chiksan Export Co.

New Officers in Falk

J. A. Butler has been named treasurer of Falk Corp., Milwaukee. Formerly assistant treasurer and comptroller, he has been associated with the company for 11 years and assistant treasurer since 1941. A certified public accountant for many years before joining Falk, he is a member of the Wisconsin Society of Public Accountants and the Comptrollers Institute of America.

The former assistant comptroller, Joseph B. Cibulka, was appointed comptroller. He will also continue his duties as office manager. A Falk employe for the past 30 years, he is a member of the American Institute of Accountants, the National Association of Cost Accountants, and the Wisconsin and Milwaukee societies of Certified Public Accountants.

Richard S. Falk, assistant to the president, is the new assistant treasurer.

Fair to Shreveport

D. J. FAIR

Minneapolis-Honeywell Regulator Co. announces that D. J. Fair will be transferred from the Dallas office and will open a district office for the Brown Instruments division in Shreveport. Offices will be located at 330 Garrett Building, 940 Margaret Place, Shreveport. Fair has been assigned to the Dallas office as industrial sales engineer for the past 18 months and in opening the Shreveport office will continue to serve customers in the East Texas, northern Louisiana, and sonthwest Arkansas areas.

Additional personnel have been added to the Brown Instruments division in the Dallas office. Charles F. Woods will continue to assist Fair in the territory.

Smith Joins Nelson Howard

Jack F. Smith of 2214 G Street, Bakersfield, Calif., has joined the firm of Nelson Howard Co., whose headquarters are at 406 Kress Building, Long Beach, to represent it as sales engineer in the San Joaquin Valley.

Smith has had wide experience in and around Bakersfield for the past several years, having worked as driller and derrick man for several prominent operating companies and contractors. He is also widely known in the Valley as a former salesman for a well-known washing tool company.

He may be reached through the L. W. Potter Trucking Co. at Bakersfield.

New superacidizer of Halliburton Oil Well Cementing Co. is built on a new model F.W.D. tractor which also pulls a 2,000-gal. acid trailer. The tractor is powered by diesel engines equipped with large ported liners and 70-mm. injectors which enable it to deliver 123 hp. at 1,800 r.p.m. The high-pressure, high-volume pump is connected to the power takeoff shaft by a special chain case of exclusive Howco design, which is completely enclosed and has a self-contained oiling system

Lynch and Woods To South America

G. I. Lynch, Lee C. Moore Corp.'s export manager, and R. D. Woods, superintendent of the Tulsa plant, left the United States recently for an extended business trip through Venezuela and Peru.

They will visit a number of oil companies now using Lee C. Moore equipment. Woods will remain in South America for some time to serve as an adviser on the use of Moore products.

(Continued on page 153)